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Sampling and Analysis of 100 Area Springs

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EXECUTIVE SUMMARY

This report is submitted in fulfillment of Hanford Federal Facility Agreement and Consent Order Milestone M-30-01, Submit a report to EPA and Ecology evaluating the impact to the Columbia River from contaminated springs and seeps as described in the operable unit work plans listed in M-30-03.

Springs, seeps, sediments, and the Columbia River were sampled for chemical and radiological analyses during the period September 16 through October 21, 1991. A total of 26 locations were sampled. Results of these analyses show that radiological and nonradiological contaminants continue to enter the Columbia River from the retired reactor areas of the 100 Area via the springs.

Contaminants are entering the Columbia River through springs along the Hanford Reach. However, the concentrations of contaminants in river water samples are generally below analytical detection limits. At locations where concentrations are above detection limits, with the exception of specific noted locations, the concentrations are significantly lower than drinking water standards. Samples of all water collected near the Hanford Townsite showed no detectable quantities of radionuclides, and the general chemistry of the river was good. Although the constituents added to the river through the Hanford springs remain in the water, the impact on the quality of the river was not discernible due to the high-dilution factor.

The primary contaminants in the springs are strontium-90, tritium, and chromium. These contaminants were detected in concentrations above drinking water standards. Analysis of total organic carbon were run on all water samples collected; there is no conclusive evidence that organic constituents are entering the river through the springs. Total organic carbon analyses were generally higher for the surface water than for the springs. The results of this study will be used to develop a focused, yet flexible, long-term spring sampling program.

Analysis of Columbia River water samples collected at the Hanford Townsite (i.e., downstream of the reactor areas) did not detect any Hanford-specific contaminants.

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CONTENTS

1.0	INTRODUCTION	1
	1.1 PURPOSE AND SCOPE	1
	1.2 OVERVIEW	1
	1.3 PREVIOUS STUDIES	3
	1.4 RELATIONSHIP TO THE GROUNDWATER MONITORING PROGRAM	3
2.0	HYDROLOGIC SETTING	3
3.0	SPRINGS	4
	3.1 SELECTION OF SPRINGS	4
	3.2 SAMPLING	5
	3.2.1 River Stage	5
	3.2.2 Evaluation of Springs Prior to Sampling	5
	3.2.3 Sample Collection	14
	3.2.4 Sample Handling	14
	3.2.5 Quality Control/Quality Assurance	27
	3.3 DATA ASSESSMENT	27
	3.3.1 Primary Contaminants	28
	3.3.2 Spring Discharges by Area	28
4.0	PRELIMINARY ASSESSMENT OF IMPACT	34
	4.1 COLUMBIA RIVER	34
	4.2 SPRINGS	34
5.0	RECOMMENDATIONS	35
	5.1 PROCEDURAL CHANGES	35
	5.1.1 Presampling Trend Measurements	35
	5.1.2 Locating Identification Cairns	35
	5.1.3 Sediment Sample Depth	35
	5.1.4 Installation of Well Points	36
	5.1.5 Sample Collection Sequence	36
	5.1.6 Sample Containers	36
	5.2 ADMINISTRATIVE/PROCESS CHANGES	37
	5.2.1 Communication	37
	5.2.2 Sample Refrigeration	37
	5.2.3 Flow Control	37
	5.2.4 Instruments	37
	5.2.5 Absolute Location	37
	5.2.6 Spring Notation	37
	5.3 SCOPE CHANGES	38
	5.3.1 Numbers of Springs Sampled	38
	5.3.2 Collection of Near Shore River Samples	38
6.0	REFERENCES	38

CONTENTS (cont)

APPENDICES:

A. HANFORD REACH SPRING SAMPLING PROCEDURE. A-1
B. NONCONFORMANCES AND VARIANCES TO APPROVED PROCEDURE. B-1
C. CHEMICAL ANALYSES OF WATER SAMPLES. C-1
D. RADIOLOGICAL ANALYSES OF WATER SAMPLES D-1
E. CHEMICAL AND RADIOLOGICAL ANALYSES OF SEDIMENTS. E-1

FIGURES:

1. Locations of Spring Sampled During 1991. 2
2. Relationship of 10-Year Average, 1991 14-day Average, and Daily Discharge. September 16 to October 21, 1991. 7
3. Time vs. Temperature, 100-B/C Area. 8
4. Time vs. Temperature, 100-D/K Areas. 9
5. Time vs. Temperature, 100-N Area. 10
6. Time vs. Temperature, 100-H Area. 11
7. Time vs. Temperature, 100-F Area. 12
8. Time vs. Temperature, Hanford Townsite. 13
9. Time vs. pH, 100-B/C Area. 15
10. Time vs. pH, 100-D/K Areas. 16
11. Time vs. pH, 100-N Area. 17
12. Time vs. pH, 100-H Area. 18
13. Time vs. pH, 100-F Area. 19
14. Time vs. pH, Hanford Townsite. 20
15. Time vs. Electrical Conductivity, 100-B/C Area. 21
16. Time vs. Electrical Conductivity, 100-D/K Areas. 22
17. Time vs. Electrical Conductivity, 100-N Area. 23
18. Time vs. Electrical Conductivity, 100-H Area. 24
19. Time vs. Electrical Conductivity, 100-F Area. 25
20. Time vs. Electrical Conductivity, Hanford Townsite. 26

TABLES:

1. Columbia River Discharge, Historical and Period of Sampling. 6
2. Drinking Water Standards for Prime Hanford Contaminants (40 CFR 141). 27

1.0 INTRODUCTION

Springs and seeps discharge groundwater to the Columbia River along both banks within the Hanford Reach. The springs located along the Benton County bank are potentially impacted by nuclear operations on the Hanford Site.

1.1 PURPOSE AND SCOPE

This study was initiated, in fulfillment of TPA Milestone M-30-01, to evaluate the impact the Columbia River from contaminated springs and seeps. This was done by ascertaining the concentrations of chemical and radiological constituents discharged through springs into the Columbia River. Definition of the chemical and radiological concentrations retained on sediments adjacent to springs was attempted. Sediment samples were collected adjacent to the springs to indicate retention of contaminants by the sediments. Near-shore river water samples were also collected adjacent to the springs.

River, spring, and sediment sampling was limited to those locations along the Hanford Site bank of the Columbia River where springs discharged at sufficient volume to allow sampling. The area of interest (Figure 1) extended from immediately above the 100-B/C Area water intake (3.7 mi [6.0 km] below the Vernita Bridge) to the Hanford Townsite (25.2 mi [40.6 km] below the bridge.)

Sampling was conducted during the period of annual minimum stream flow so that the greatest number of springs would be exposed and to provide the greatest probability to sample the highest concentrations of potential contaminants in the spring water by minimizing the effects of precedent bank storage. Maximum concentrations of contaminants would be those found in nearby groundwater that was uninfluenced by mixing with surface water.

1.2 OVERVIEW

Water and sediment samples were collected from 26 locations between September 16, 1991, and October 21, 1991, coinciding with the normal low-flow period of the Columbia River. Samples were submitted for chemical and radiological analyses following onsite screening for radioactivity. Samples were controlled under standard chain-of-custody procedures (WHC 1988) following their collection.

Samples were collected from the south and west bank of the Columbia River, within the Hanford Reach. The most upstream sample was collected above the intake structure at the 100-B/C reactor area. Maps of springs sampled during 1984 and 1988 were used to help locate probable spring locations, no springs were noted above this location. The most downstream sample was collected in the vicinity of the Hanford Townsite downstream of the 100 Area National Priority List site boundary.

Samples were collected in accordance with a sampling procedure developed specifically for this task (Appendix A). Onsite screening for radioactive constituents was conducted at the radiological laboratory at the 100-N Area. No samples were found to exceed radiological standards for shipping.

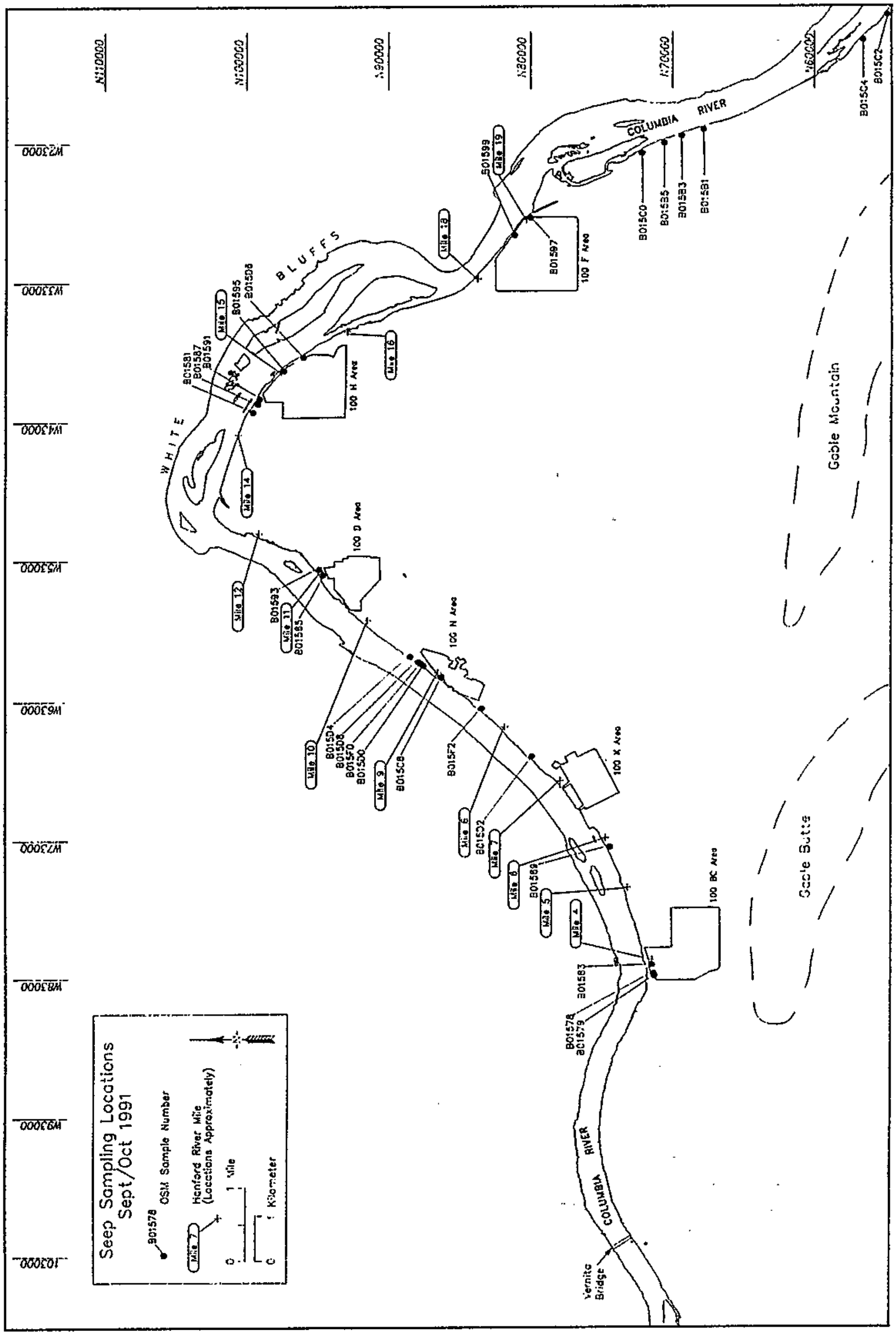

Figure 1. Locations of Spring Sampled During 1991.

9 2 1 2 5 1 0 1 3 0

1.3 PREVIOUS STUDIES

Studies addressing groundwater discharge impacts on the quality of the Columbia River have been conducted along the Hanford Reach over the past several years. These studies were conducted through Pacific Northwest Laboratory (PNL) as part of the Environmental Assessment Program for the Hanford Site [McCormack and Carlile (1984) and, Dirkes (1990)]. This study differs from the earlier efforts in that the samples were collected, handled, and analyzed in accordance with established and defined protocols. Approximate sampling locations used in the previous efforts were obtained from PNL on map plots at a scale of 1:2000. The detailed work of walking the riverbank and locating individual springs conducted by McCormack and Carlile (1984) was not repeated during this effort. Those areas indicated on the plots provided by PNL were surveyed in the field to pinpoint springs and seeps that could be sampled.

1.4 RELATIONSHIP TO THE GROUNDWATER MONITORING PROGRAM

Groundwater beneath the Hanford Site is monitored through several ongoing programs. The site-wide Groundwater Monitoring Program is conducted by PNL for the U.S. Department of Energy (DOE). Sampling frequencies and analytical parameters used in this program are determined through an assessment of the activities that can affect groundwater quality. The program is used to assess onsite and offsite impacts due to Hanford groundwater discharges. In addition to the site-wide program, specific subareas are monitored on supplemental schedules for other parameters. Schedules for special efforts are driven by operating needs and/or the requirements of investigations under the *Comprehensive Environmental Response Compensation and Liability Act of 1980* and *Resource Conservation and Recovery Act of 1976*. The data developed during this effort provide a point-in-time check of the Hanford Site contributions to the chemistry of the Columbia River.

2.0 HYDROLOGIC SETTING

The Hanford Reach of the Columbia River extends from Priest Rapids Dam, approximately 10 mi (16 km) upstream of the Vernita Bridge to the Hanford Site 300 Area, approximately 44 mi (71 km) downstream of the bridge. The river in this reach is the only remaining free flowing section above Bonneville Dam.

In this reach of the river, flow is controlled by Priest Rapids Dam. There are no backwater effects of the downstream impoundment at McNary Dam. Flow is contained within the natural channel of the river. The Columbia River exhibits a normal distribution of discharge that peaks between April and June due to snowmelt and is at its minimum during the late fall and early winter. Superimposed on this natural flow distribution are hourly, daily, and weekly perturbations caused by power generation through the network of Columbia River hydroelectric dams, most directly by Priest Rapids Dam, approximately 13 mi (21 km) upstream of the first sampling point.

During the periods of peak flow (annual and daily), the river may rise above the level of adjacent groundwater, causing a reversal of flow direction. Surface water is temporarily stored in the bank sediments during these events. As river stage drops, this water is discharged from the sediments back into the river; this phenomenon is referred to as 'bank storage'. During extended periods of high river stage, the groundwater is restricted from discharging to the river by the 'hydraulic dam' of temporarily stored surface water. As the river level recedes a mixture of surface and groundwater is released. As time progresses the discharged water becomes more representative of groundwater.

Groundwater discharges to the Columbia River along both banks within the Hanford Reach. These discharges are the result of natural and anthropogenic influences. Groundwater flows in a general northerly to easterly direction from the highlands that border the Hanford Site toward the Columbia River. This natural flow system is influenced by a variety of activities on the Hanford Site that dispose of water to the ground. This water is predominately discharged to the ground in the central portions of the site, and does include or has included contaminated waste streams. Plutonium production reactors located adjacent to the river discharged large volumes of water (contaminated and noncontaminated) directly to the river and to disposal trenches located near the river. These activities have resulted in the distribution of contaminants addressed in this study.

Of interest to this study are the effects of Hanford operations on the chemistry of groundwater discharges to the river and ultimately the effects of those discharges on the quality of the Columbia River. At several locations, the groundwater discharges occur as recognizable springs emanating from the banks. Figure 1 shows the locations where springs were identified and sampled during this project.

3.0 SPRINGS

In an attempt to provide comparability with the previous PNL studies by McCormack and Carlile (1984) Dirkes (1990), maps were obtained from PNL showing the approximate locations sampled during that effort. Descriptions of the springs located between the Vernita Bridge and the Hanford Townsite were then used as a basis for developing plans and estimates of the effort required for sampling.

3.1 SELECTION OF SPRINGS

The spring location maps provided by PNL were field checked to assess their representativeness under the 1991 Columbia River flow regime. Springs that were accessible for sampling were selected from the mapped locations of springs and seeps. A general selection occurred during a 1-day field reconnaissance prior to onset of sampling. As the field work continued, additional springs were located and sampled. Locations of the selected springs were mapped in the field as they were sampled.

3.2 SAMPLING

Access and availability of springs for sampling are dependant on the stage of the Columbia River. Average annual flow of the Columbia River is approximately 120,000 ft^3/s. Criteria developed for the sampling stated that sampling would be conducted only when the running 14-day average flow of the river was below 120,000 ft^3/s.

3.2.1 River Stage

River discharge at Priest Rapids Dam was obtained through the system dispatcher for the Grant County Public Utility District in Ephrata, Washington. The Hanford Reach of the Columbia River is subject to frequent and rapid changes in discharge due to operations of Priest Rapids Dam. The availability of springs for sampling and the influence of bank storage depend on river stage. Discharge during sampling was generally lowest early in the day, rising noticeably around noon and then receding sometime after dark. Over the period of this study, flows were generally highest during mid-week and lowest on the weekends. River discharge forecasts were obtained prior to attempting to sample springs exposed only at very low stage. These forecasts proved generally unreliable as power needs varied. Sampling efforts were aborted on several occasions when the river rose and inundated spring locations.

The previous 10 yr of record for daily discharge of the Columbia River at Priest Rapids Dam were obtained from the U.S. Geological Survey (USGS), Water Resources Division. A comparison of the 10-yr average derived from the USGS data and the discharge reported by the Grant County Public Utility District for the period of sampling are shown in Table 1 and graphically presented in Figure 2. Discharge during the sampling period was generally greater than the 10-yr average.

3.2.2 Evaluation of Springs Prior to Sampling

Measurements of spring temperature, pH, and conductivity were taken at 5-min intervals for a period of 1 h prior to attempting collection of samples for analysis.

Temperature: Measurements were obtained by placing the instrument thermistor probe in the spring and recording the temperature. Care was taken to minimize external influences by shading the spring during the period of measurement. Spring temperatures remained generally stable, and only one sampling point changed more than 0.7° C during the 1-hr period.

The premise behind the 1 h of measurements was that if a substantial portion of the spring discharge was derived from bank storage the temperature would be expected to approach groundwater temperature as time progressed. Figures 3 through 8 show the relationship of time verses temperature for the springs sampled. In the majority of cases, temperature had stabilized for more than three consecutive measurements before the springs were sampled.

Table 1. Columbia River Discharge, Historical and Period of Sampling (ft^3/s).

Date	10-yr 14-day Avg.[1]	'91 14-day Avg.[2]	'91 Daily
Sept-16	79,407	89,162	83,600
Sept-17	78,448	88,708	89,000
Sept-18	78,679	87,923	93,500
Sept-19	78,554	86,731	85,800
Sept-20	77,724	85,015	82,400
Sept-21	77,194	84,869	79,800
Sept-22	76,926	85,038	77,400
Sept-23	76,444	85,846	93,000
Sept-24	76,109	86,038	97,000
Sept-25	76,029	85,385	90,900
Sept-26	75,961	85,238	94,800
Sept-27	75,686	85,262	85,500
Sept-28	75,606	86,362	70,000
Sept-29	75,385	85,271	71,100
Sept-30	74,852	85,421	85,700
Oct-01	75,404	86,214	100,100
Oct-02	75,296	86,329	95,100
Oct-03	75,689	87,793	106,300
Oct-04	76,259	89,000	99,300
Oct-05	76,776	88,557	73,600
Oct-06	76,811	87,300	59,800
Oct-07	77,541	86,757	85,400
Oct-08	78,199	85,943	85,600
Oct-09	78,866	85,864	89,800
Oct-10	79,223	86,086	97,900
Oct-11	79,839	87,021	98,600
Oct-12	80,167	88,193	86,400
Oct-13	81,350	88,450	74,700
Oct-14	82,317	88,414	85,200
Oct-15	82,233	87,093	81,600
Oct-16	82,462	85,742	76,200
Oct-17	82,561	86,450	116,200
Oct-18	82,727	85,843	90,800
Oct-19	82,719	87,014	90,000
Oct-20	82,914	88,557	81,400
Oct-21	82,889	88,707	87,500

1) 10-yr 14-Day Avg -- The running 14-day average flow, derived using the 10-yr daily mean flow (USGS Data).

2) '91 14-Day Average -- The running 14-day average flow at Priest Rapids Dam, obtained from Grant County Public Utility District, for the days of concern.

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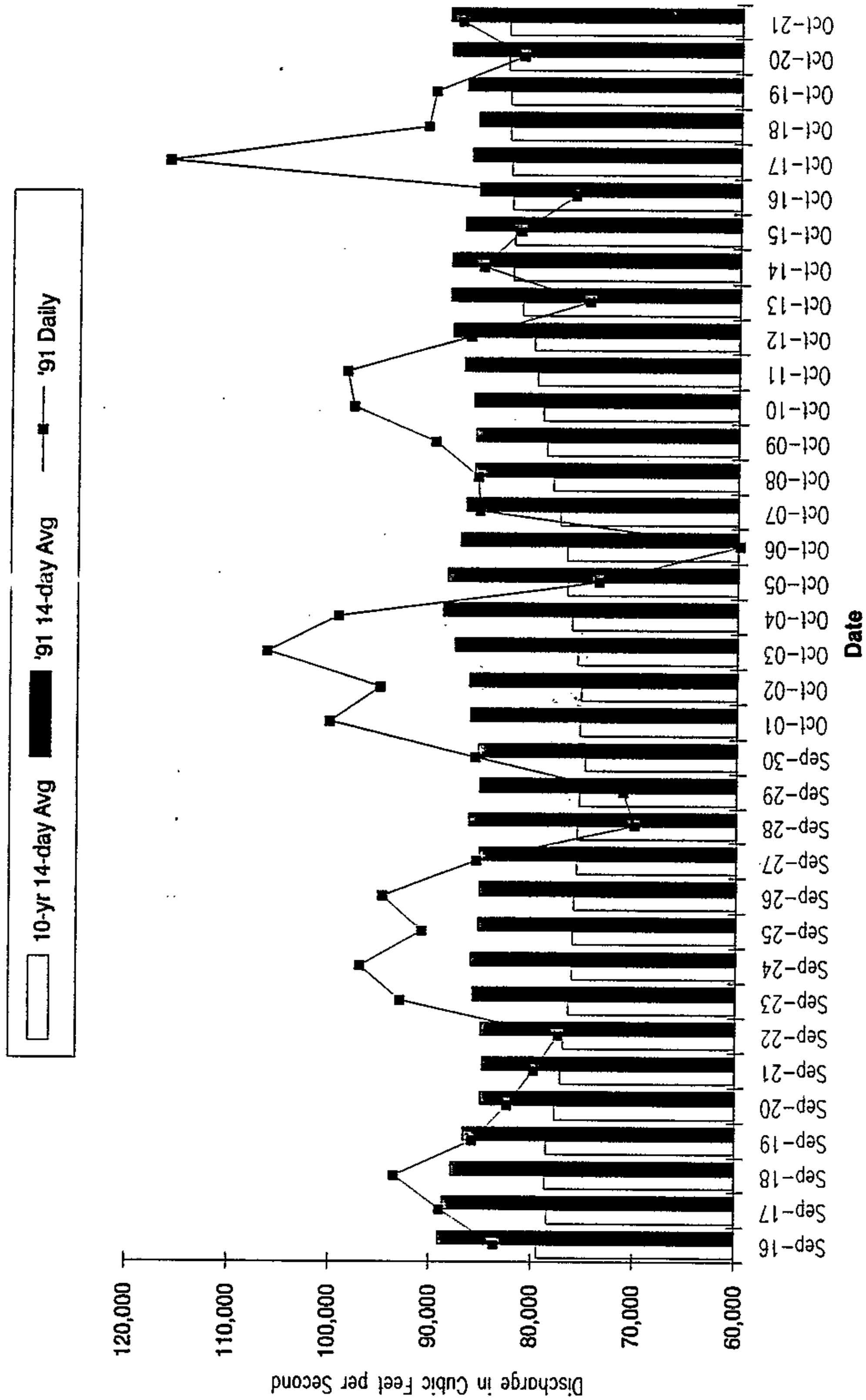

Figure 2. Relationship of 10-Year Average, 1991 14-Day Average, and Daily Discharge. September 16 to October 21, 1991.

9 2 1 2 5 4 0 1 3 6

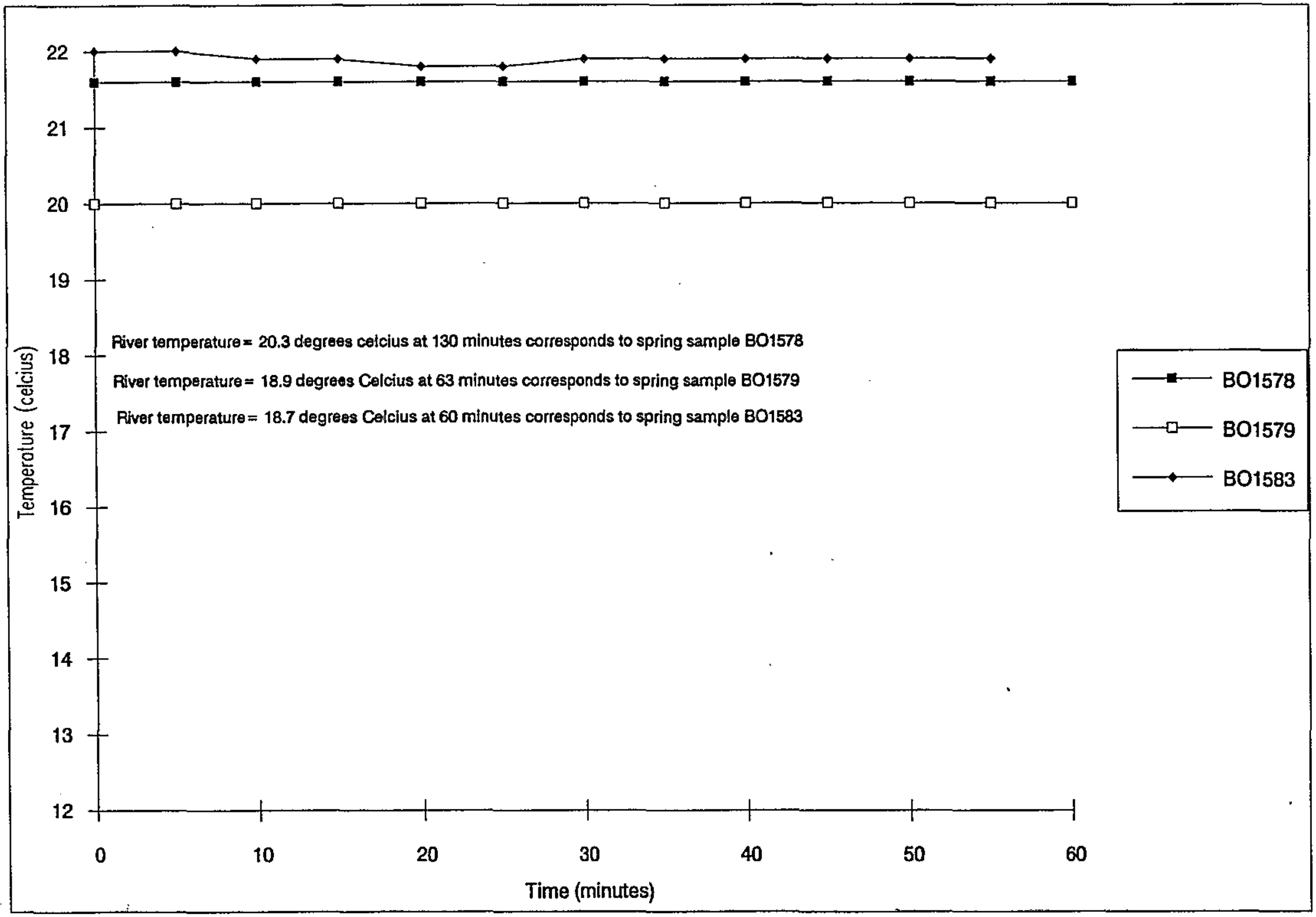

Figure 3. Time vs. Temperature, 100-B/C Area.

9 2 1 2 5 4 0 1 3 7

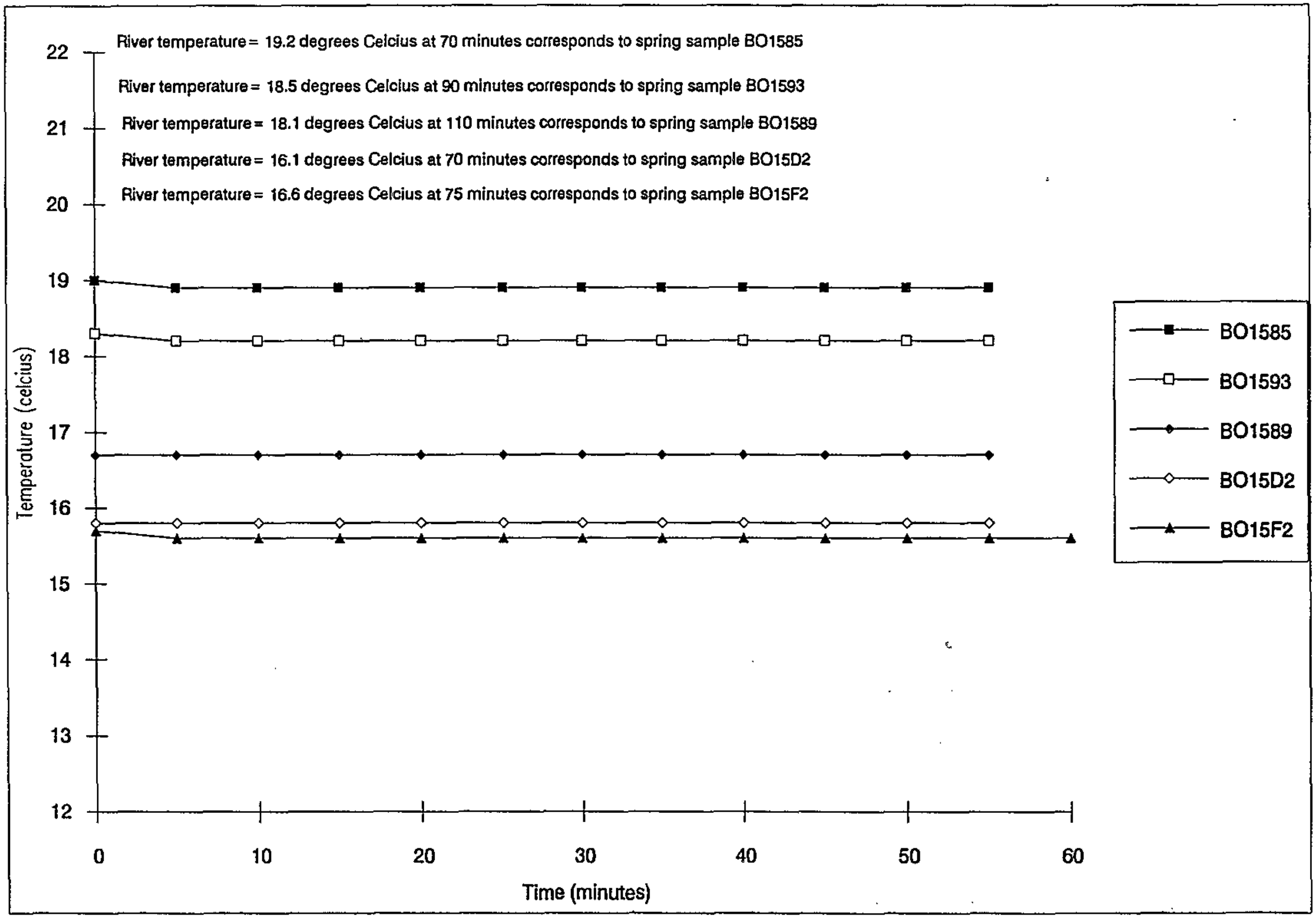

Figure 4. Time vs. Temperature, 100-D/K Areas.

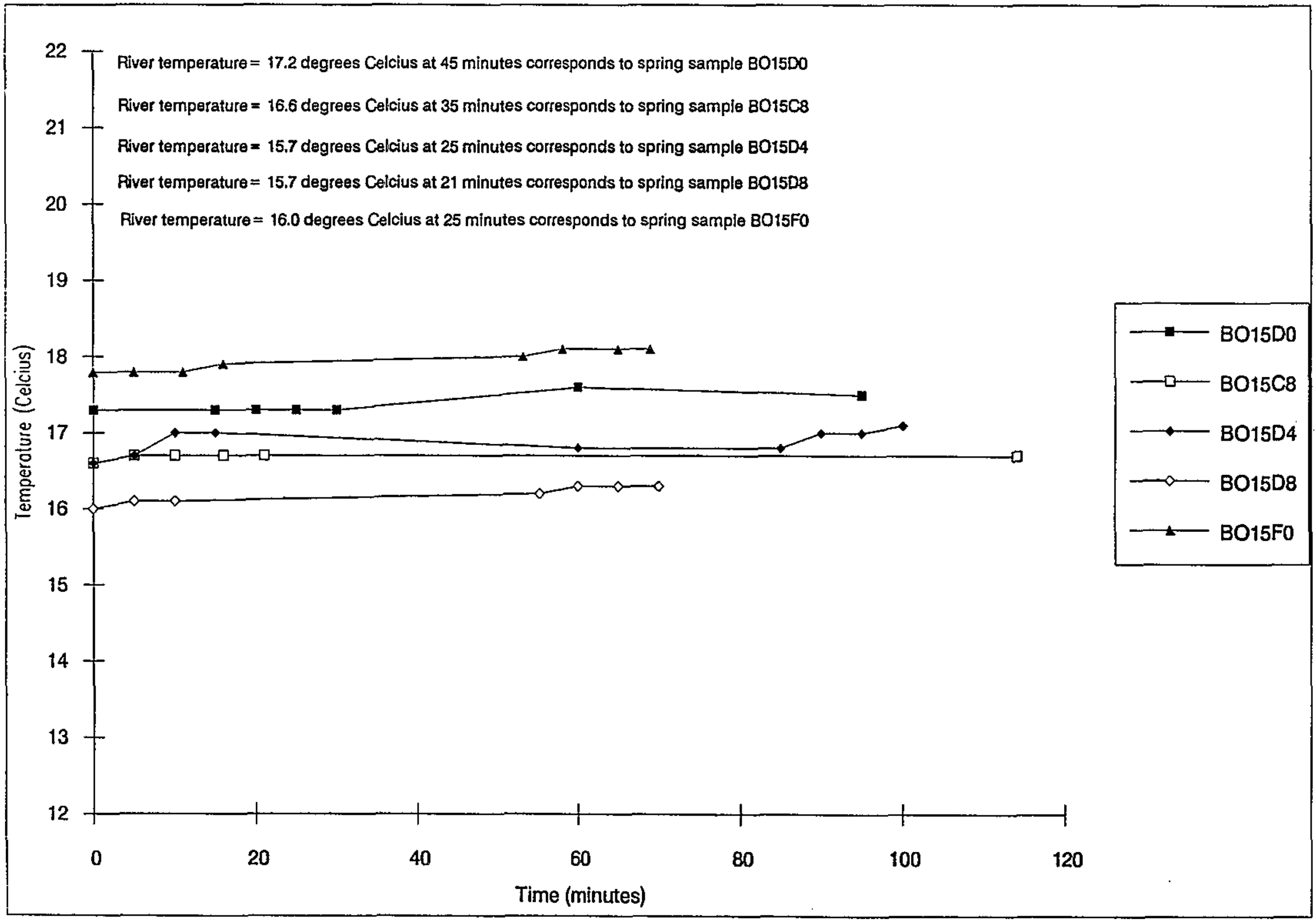

Figure 5. Time vs. Temperature, 100-N Area.

9 2 1 2 1 5 4 0 1 3 9

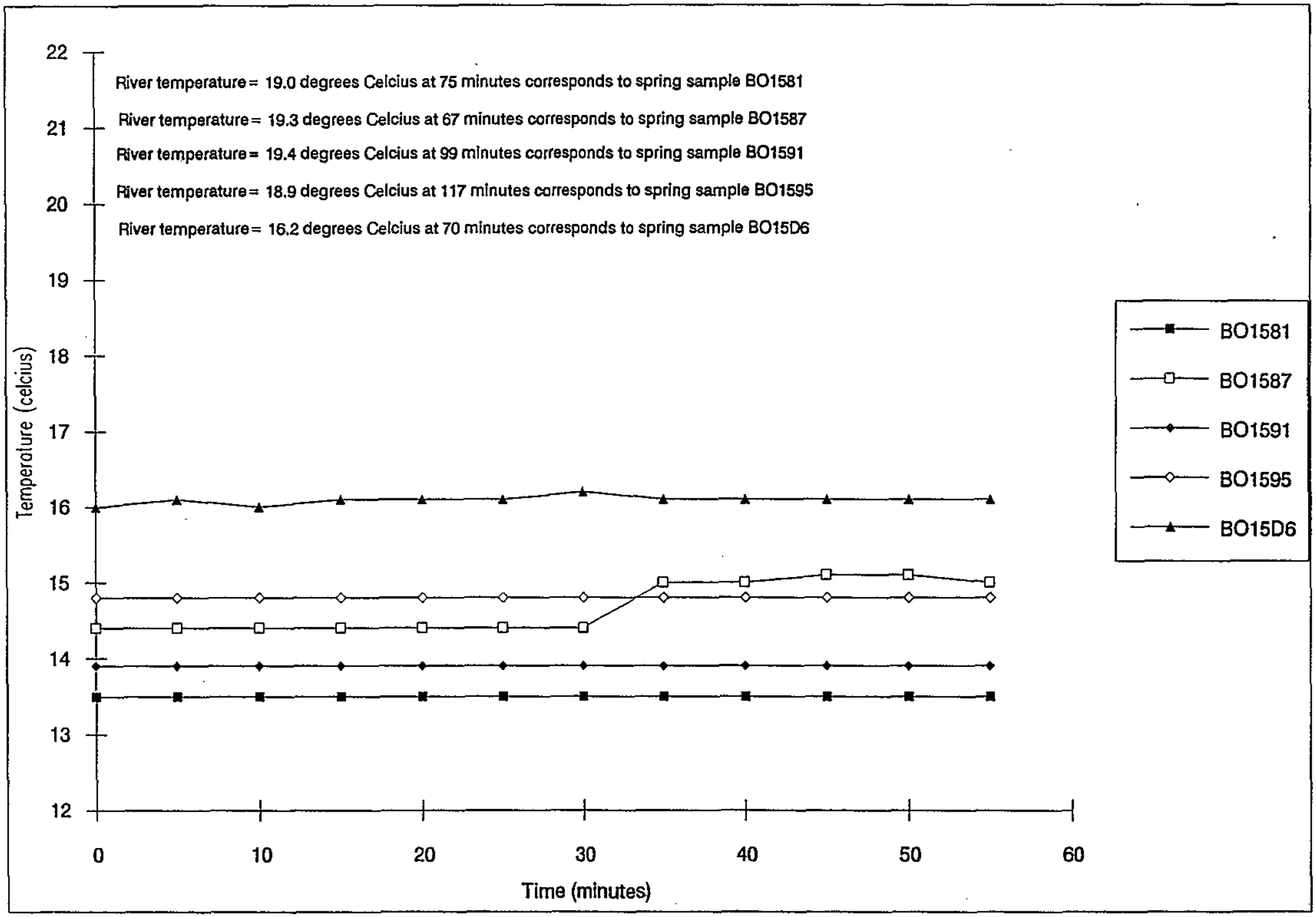

Figure 6. Time vs. Temperature, 100-H Area.

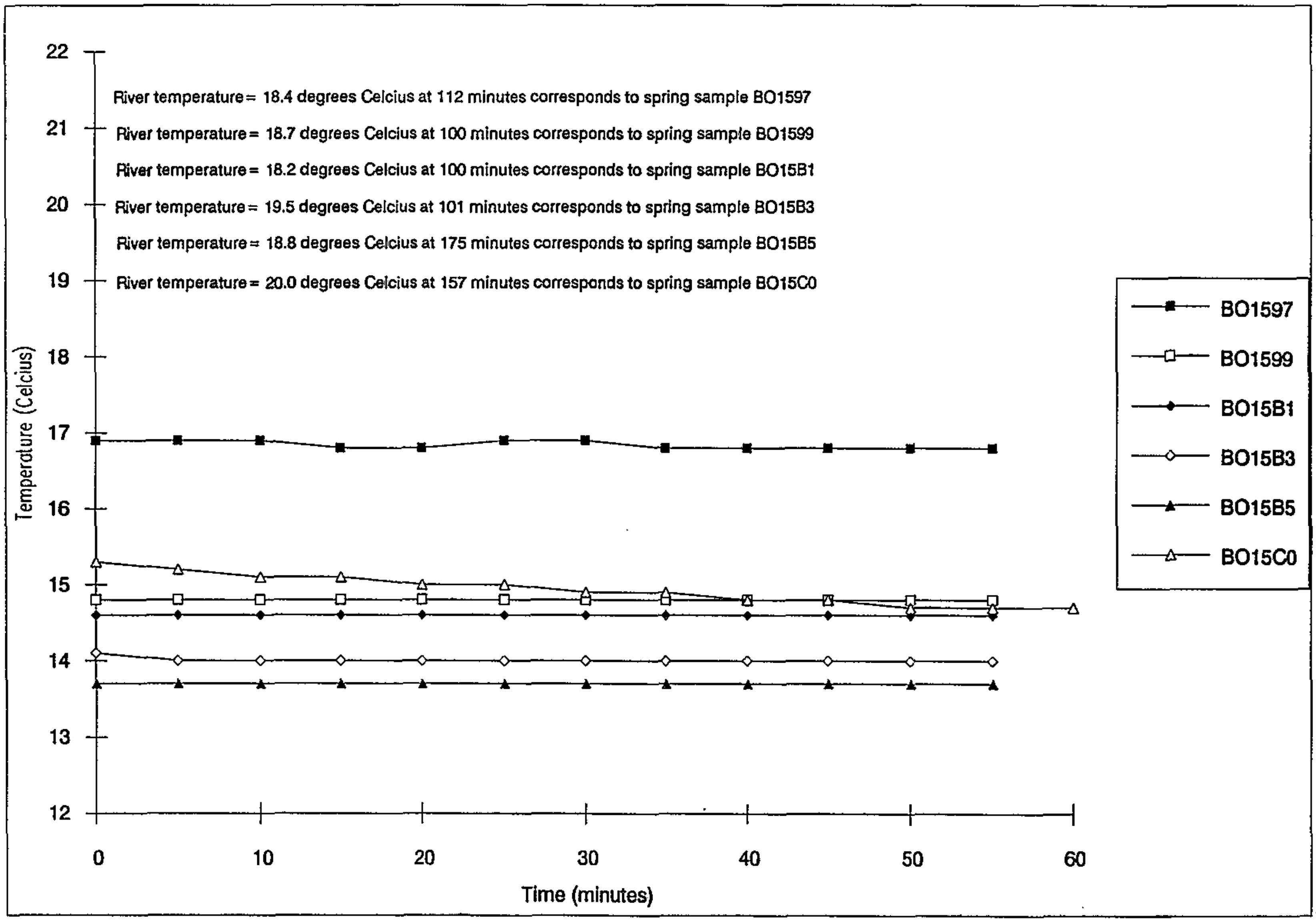

Figure 7. Time vs. Temperature, 100-F Area.

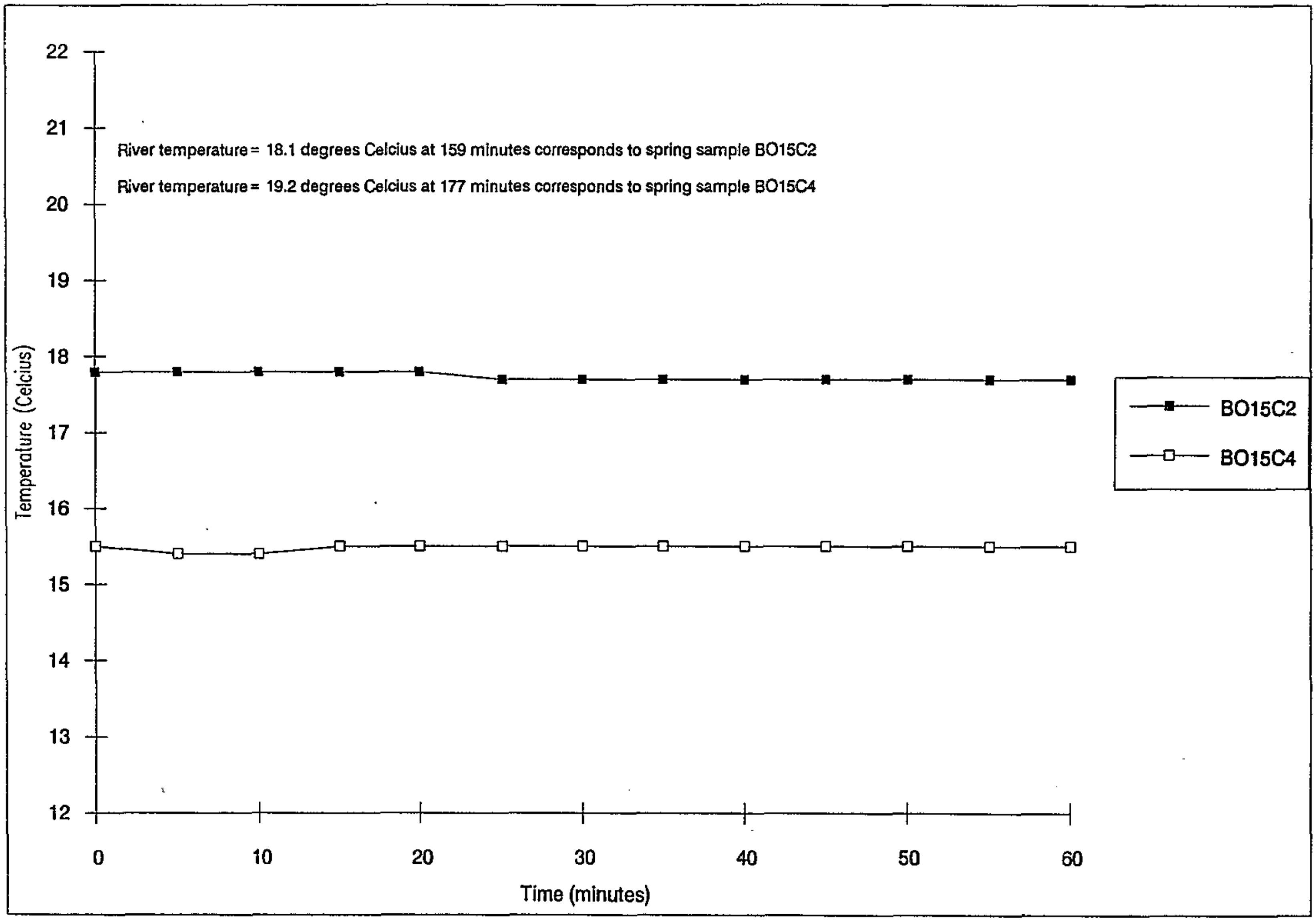

Figure 8. Time vs. Temperature, Hanford Townsite.

The pH measurements were taken by inserting the pH electrode directly into the spring. The measurement was recorded once the meter had equilibrated. The pH appeared to decrease over the period of measurement. The noted changes were consistent between springs as shown in Figures 9 through 14. The consistency of the changes suggests that pH electrode response is the most likely reason, rather than actual changes in pH.

Electrical conductivity provides a gross indicator of the total ionic strength of water (concentration of total dissolved solids). The Columbia River generally has a low-electrical conductivity, indicating the river has low-dissolved solids content. Groundwater generally exhibits higher electrical conductivity than the river due to the higher total dissolved solids content resulting from interactions with the aquifer matrix.

Measurements were taken by collecting an aliquot of water in the cup of the conductivity bridge and reading the resulting value. Values of spring electrical conductivity ranged from 140 micro siemens per centimeter (μS/cm) to 335 μS/cm. The changes of electrical conductivity with time before sampling are shown in Figures 15 through 20. Conductivity values for the river ranged from 91 μS/cm to 301 μS/cm. At 22 of the 28 locations where river conductivity was recorded, the values ranged from 91 μS/cm to 139 μS/cm.

3.2.3 Sample Collection

The procedure used for collection of spring, sediment, and river samples is included as Appendix A to this report. The procedure was developed to encompass foreseeable occurrences that might occur during field work. In some instances field operations required deviation from written protocols. In these instances deviations were recorded in the daily log and a variance or nonconformance report was prepared that described the alternate actions taken. Variance/nonconformance logs are contained in Appendix B to this report. Suggested changes to the field procedure based on experience are provided in Section 5.0, Recommendations.

3.2.4 Sample Handling

Samples were labeled, bagged, and iced immediately after collection. Aliquots of the spring water, river water, and sediment samples were transported to the Westinghouse Hanford Company (Westinghouse Hanford) Health Physics Screening Laboratory at 100-N Area for radiological screening before the primary samples were shipped offsite. Chilled samples were controlled under chain-of-custody pending receipt of permission for offsite shipment. Once permission was received, the samples were repackaged in additional ice, secured for shipment and delivered to Westinghouse Hanford Transportation for shipment to Westinghouse Hanford's contract laboratory. Analytical services for this effort were provided by TMA Norcal and Weston Analytical Services. Analyses were returned to Westinghouse Hanford Office of Sample Management (OSM) for validation.

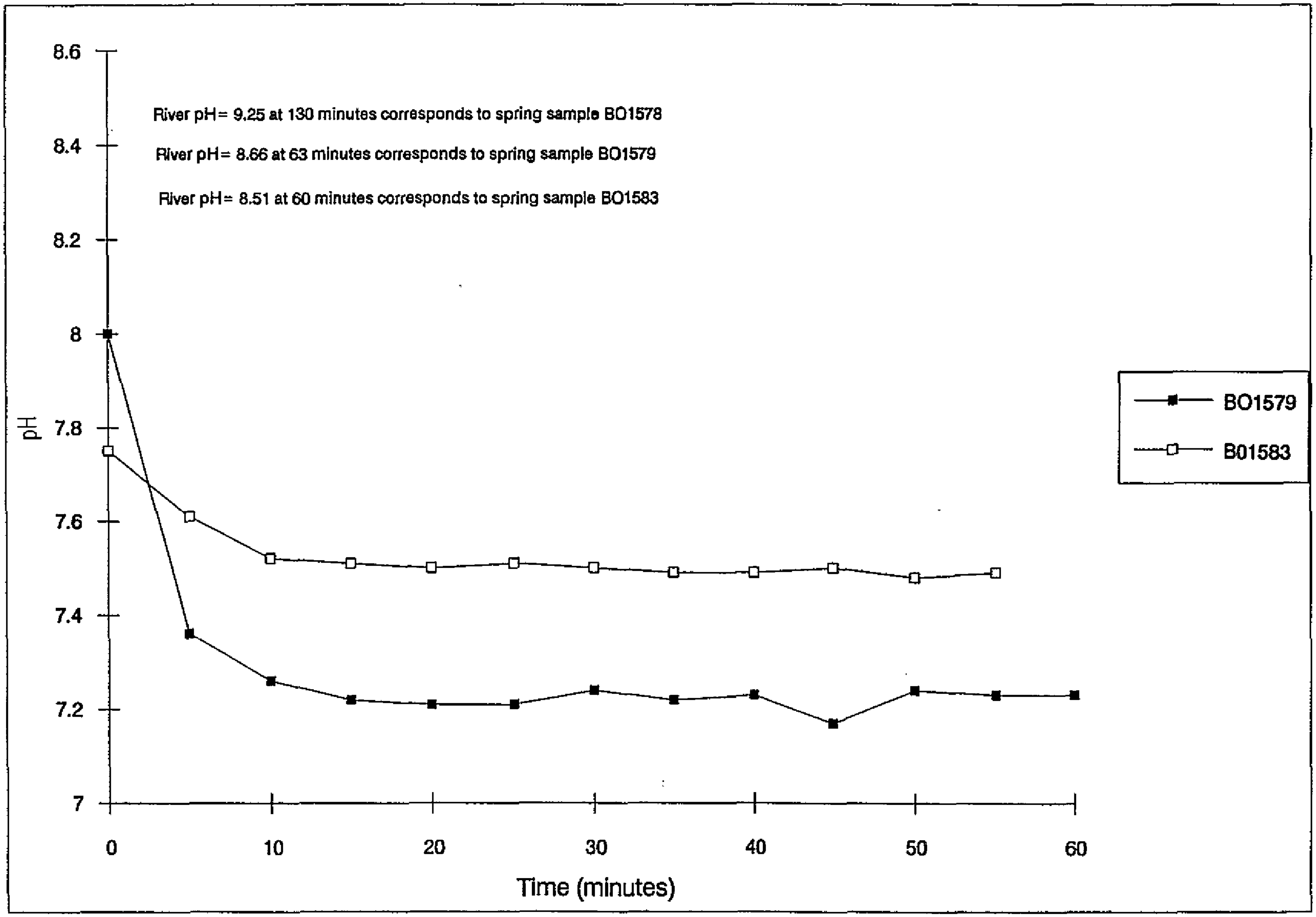

Figure 9. Time vs. pH, 100-B/C Area.

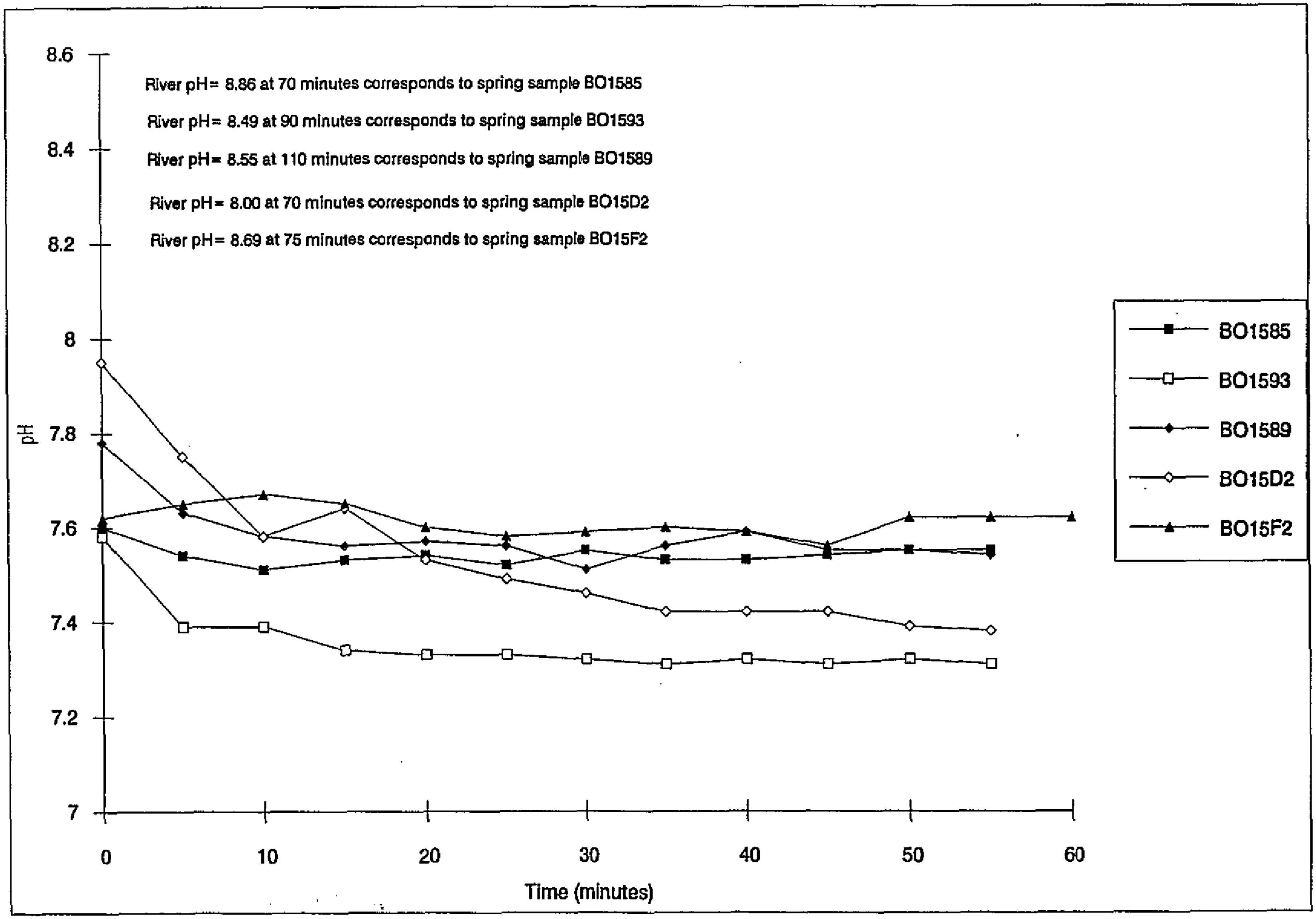

Figure 10. Time vs. pH, 100-D/K Areas.

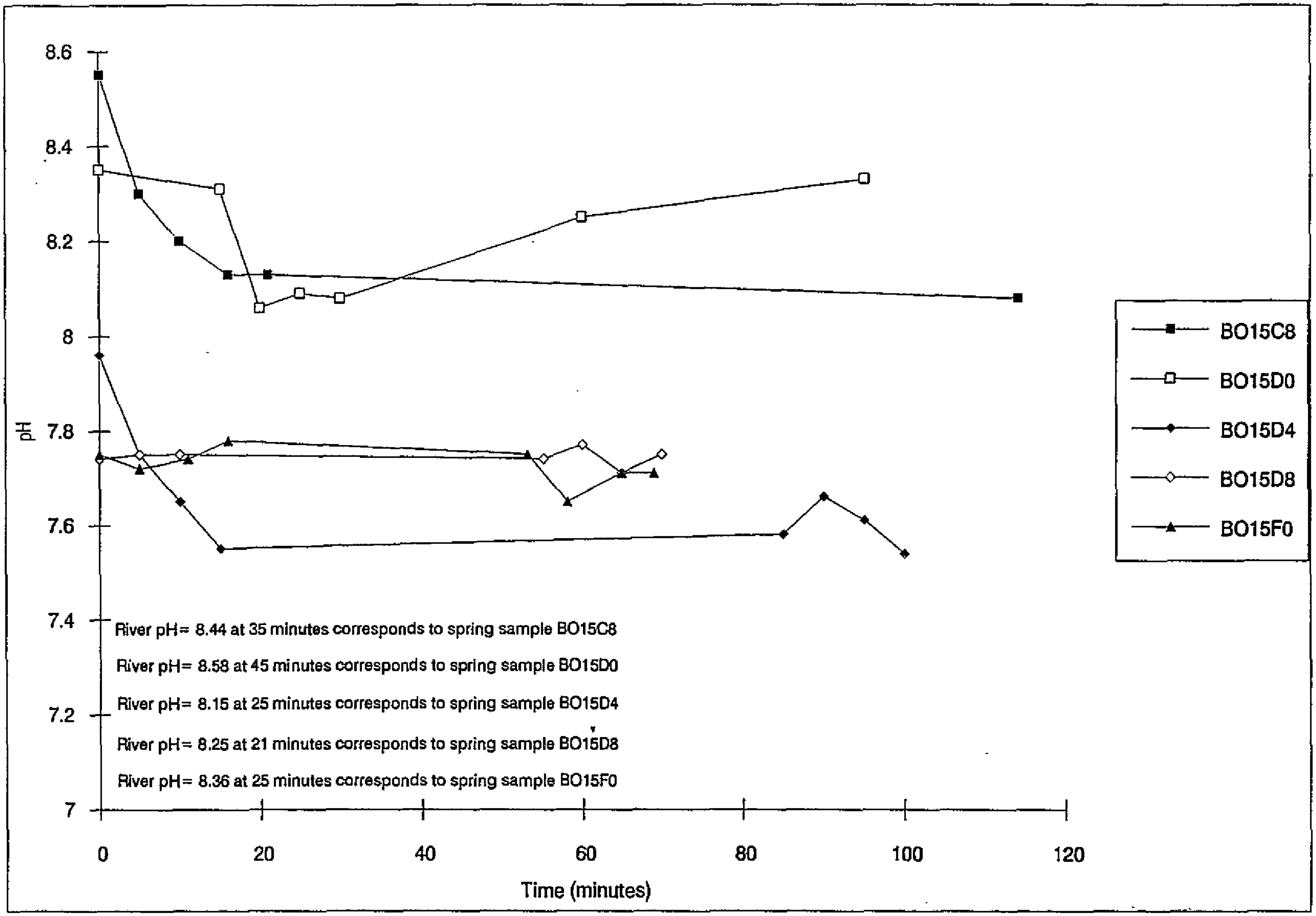

Figure 11. Time vs. pH, 100-N Area.

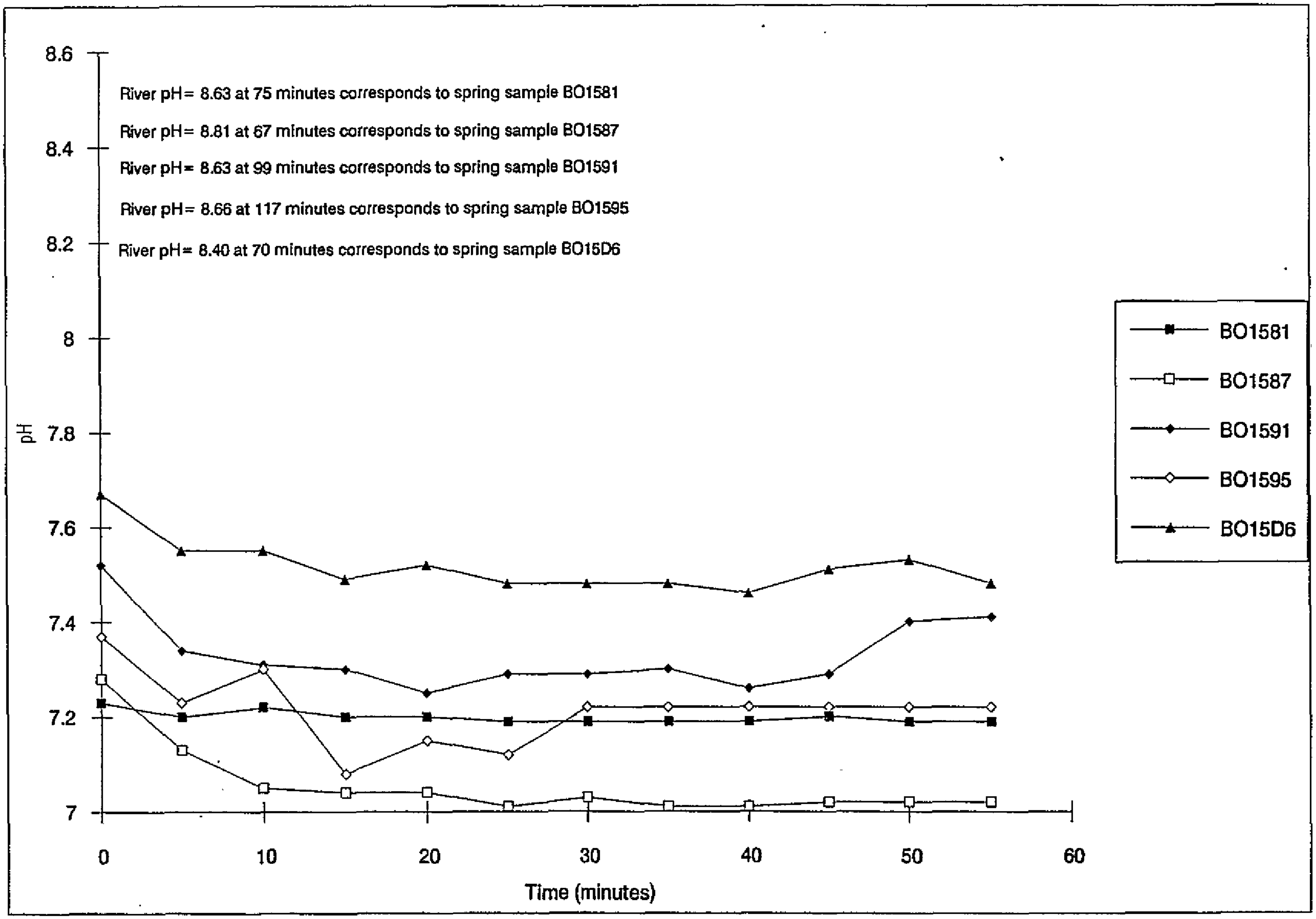

Figure 12. Time vs. pH, 100-H Area.

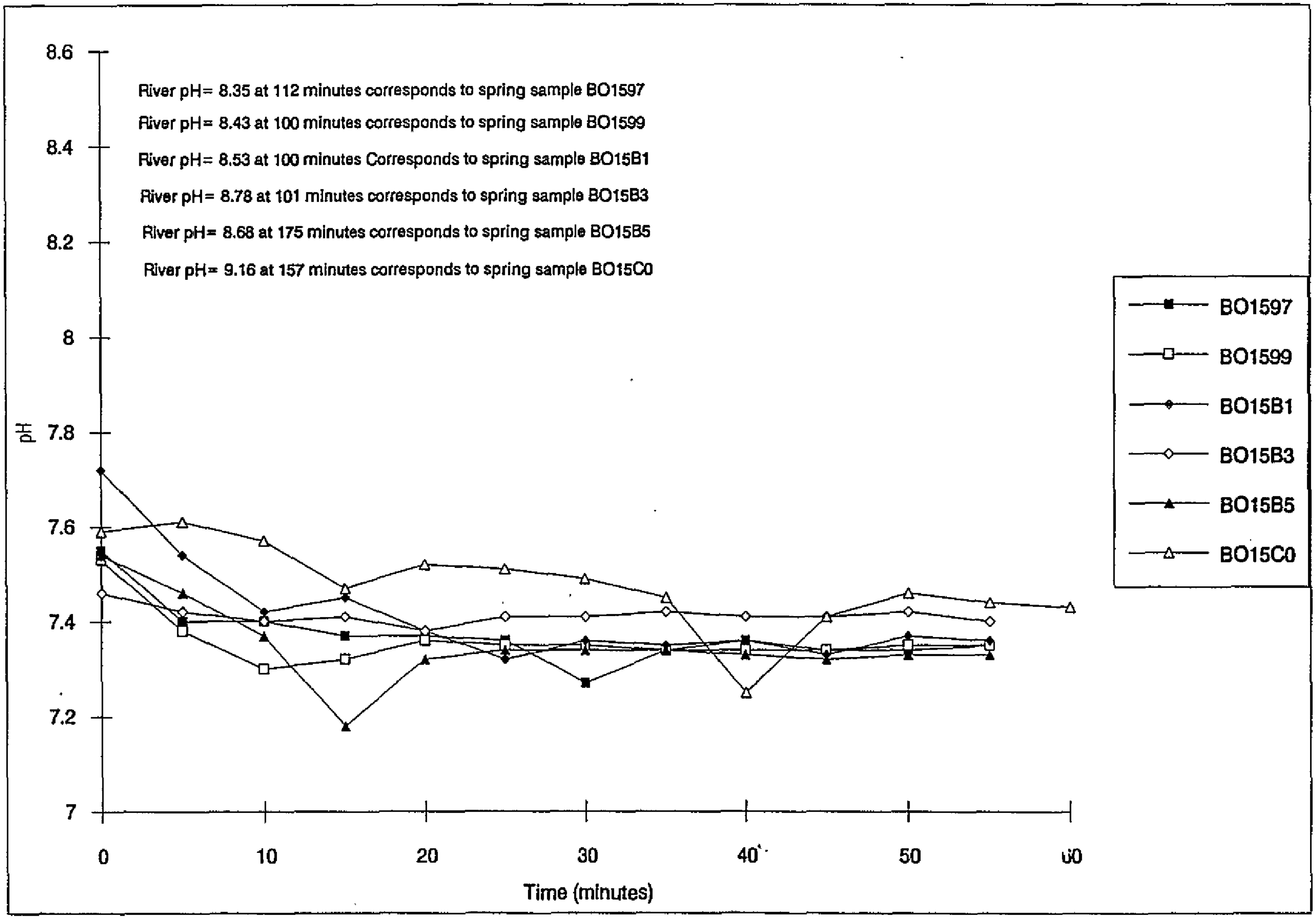

Figure 13. Time vs. pH, 100-F Area.

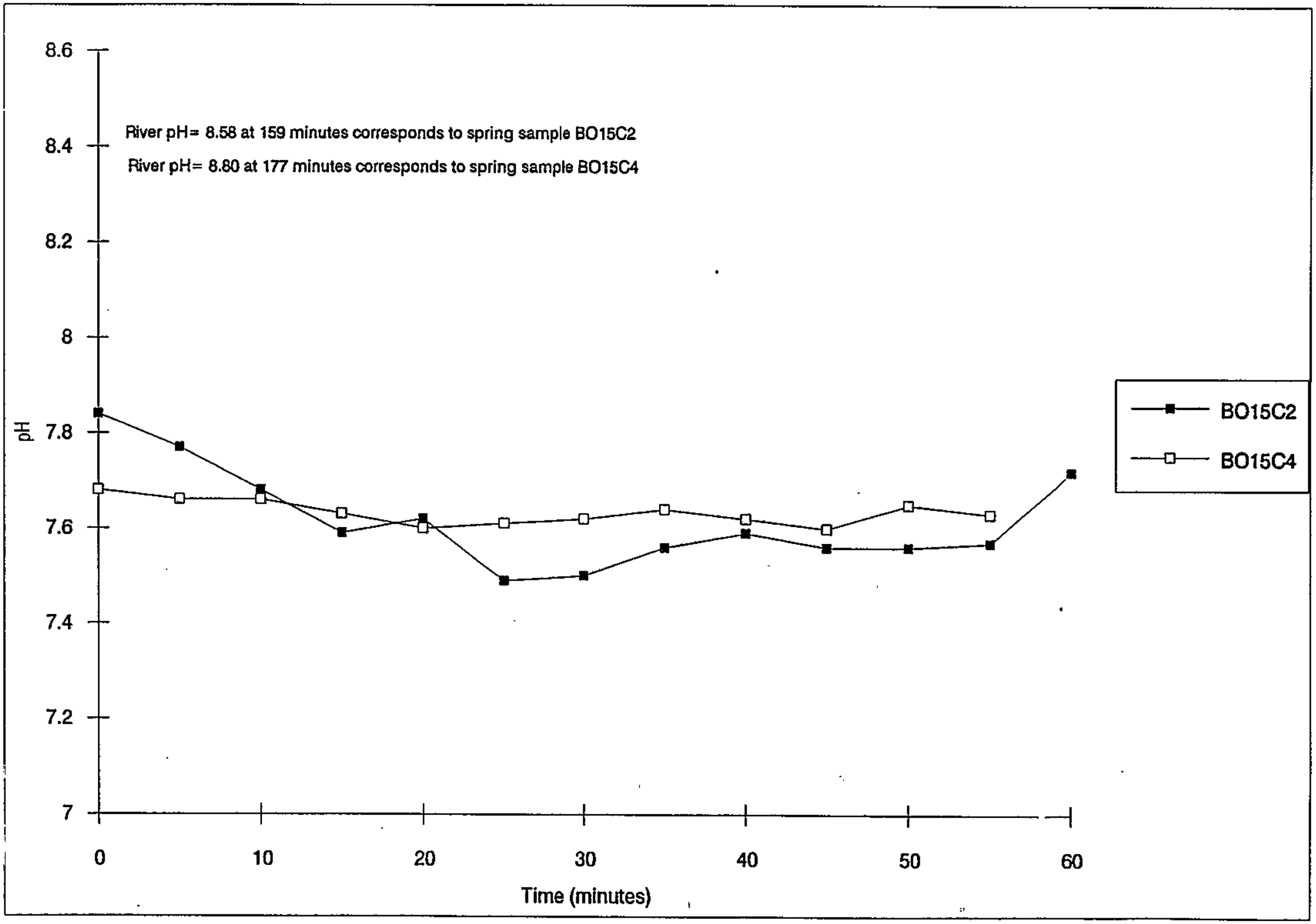

Figure 14. Time vs. pH, Hanford Townsite.

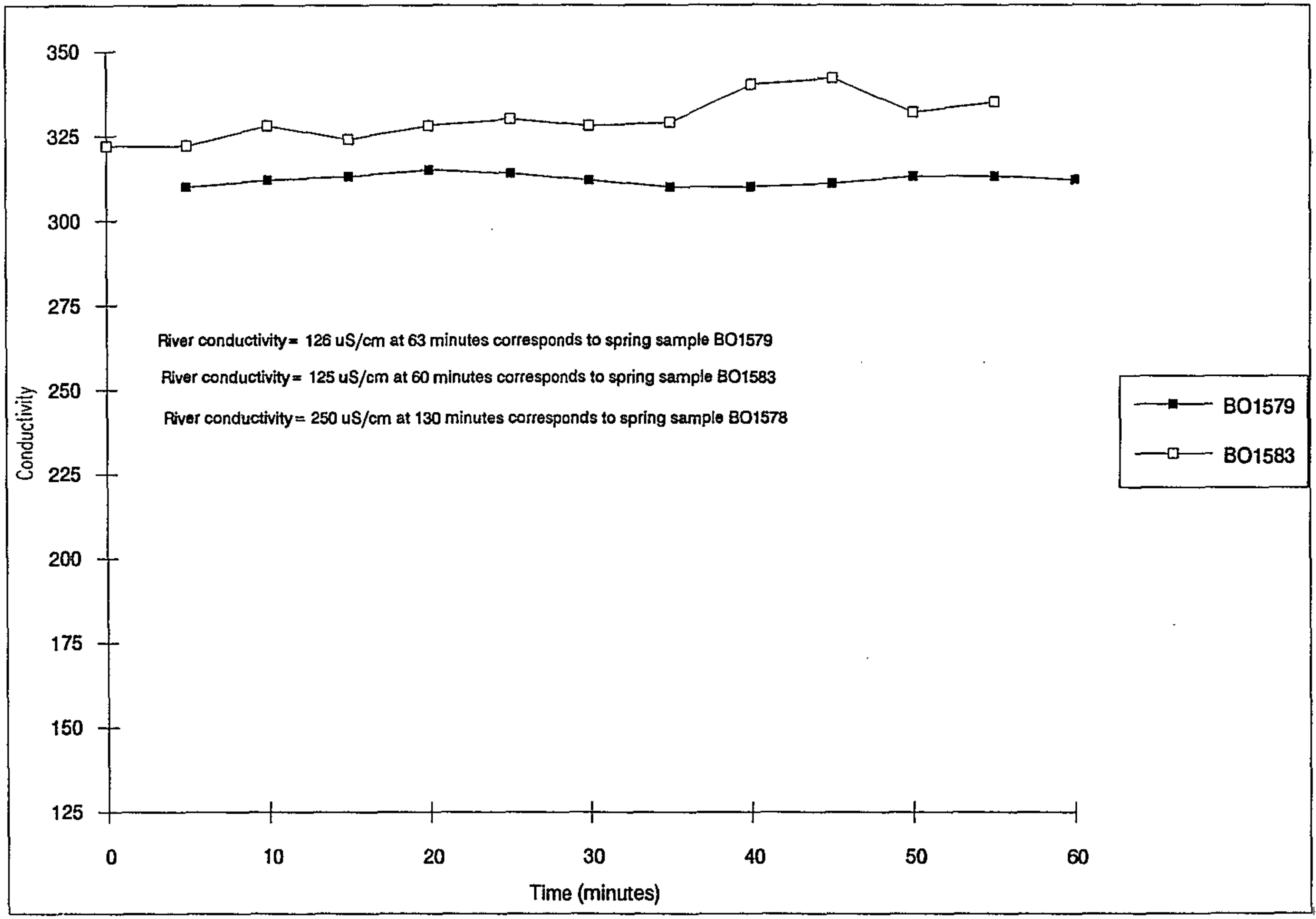

Figure 15. Time vs. Electrical Conductivity, 100-B/C Area.

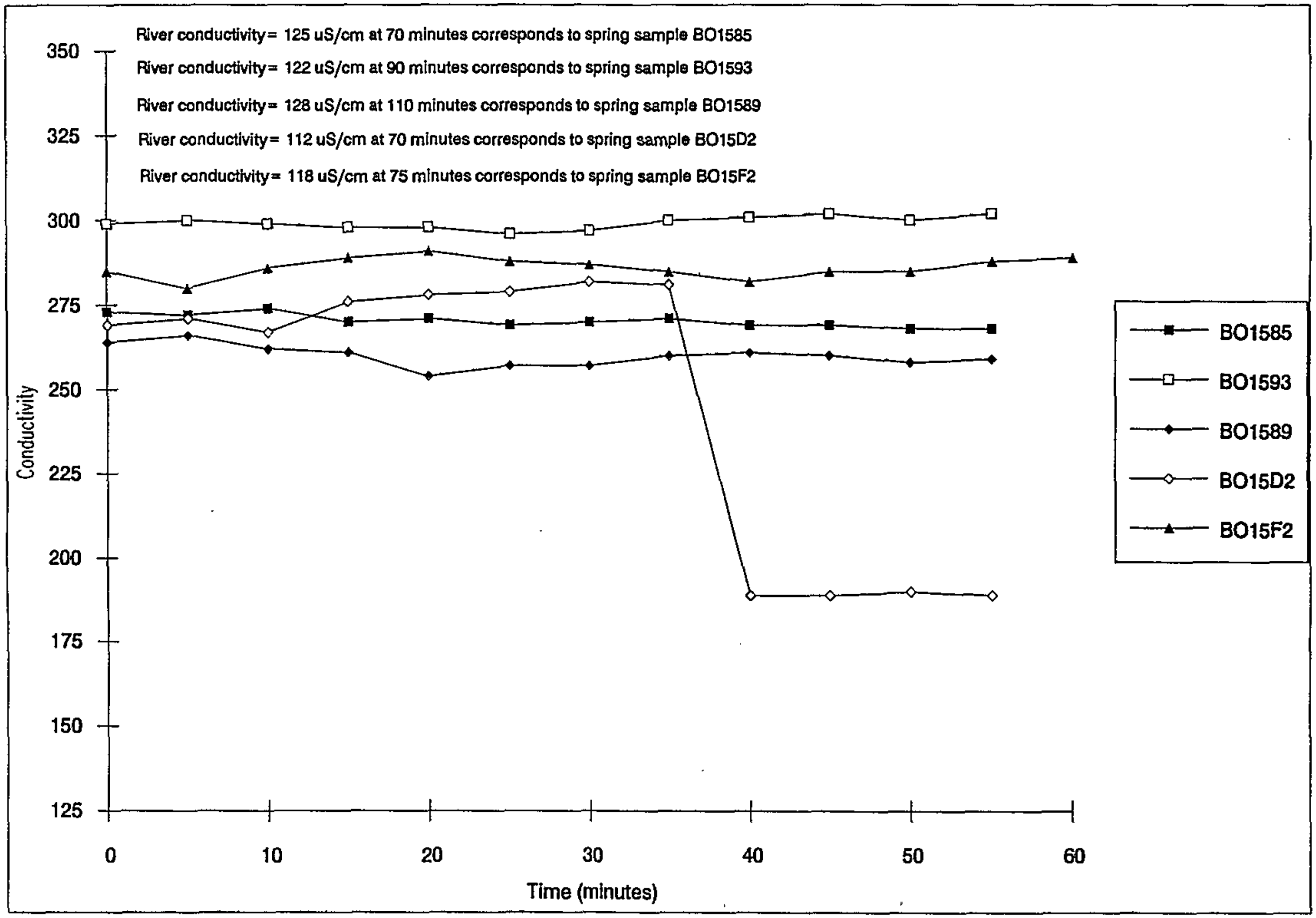

Figure 16. Time vs. Electrical Conductivity, 100-D/K Areas.

9 2 1 2 1 5 9 0 2 0 1

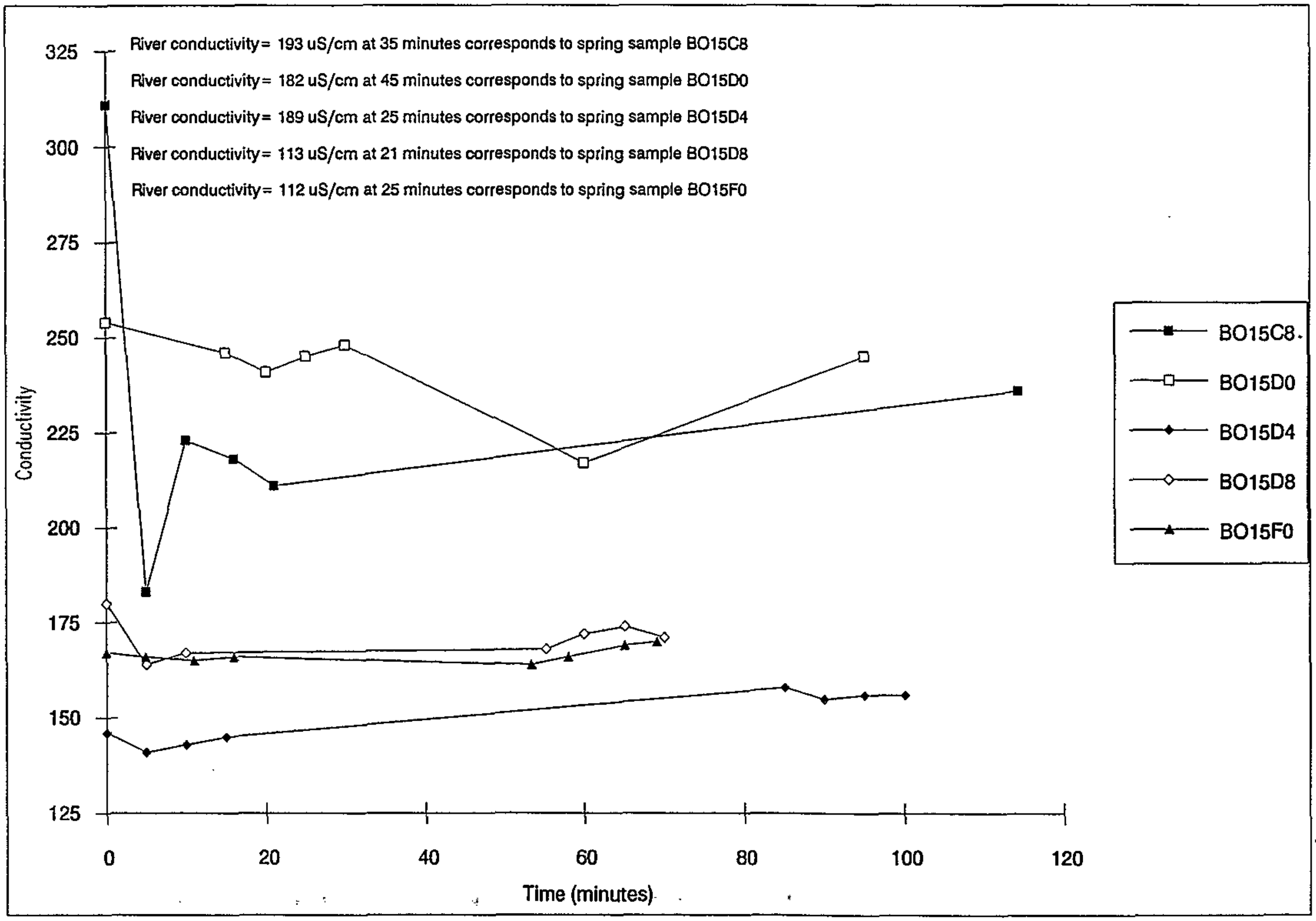

Figure 17. Time vs. Electrical Conductivity, 100-N Area.

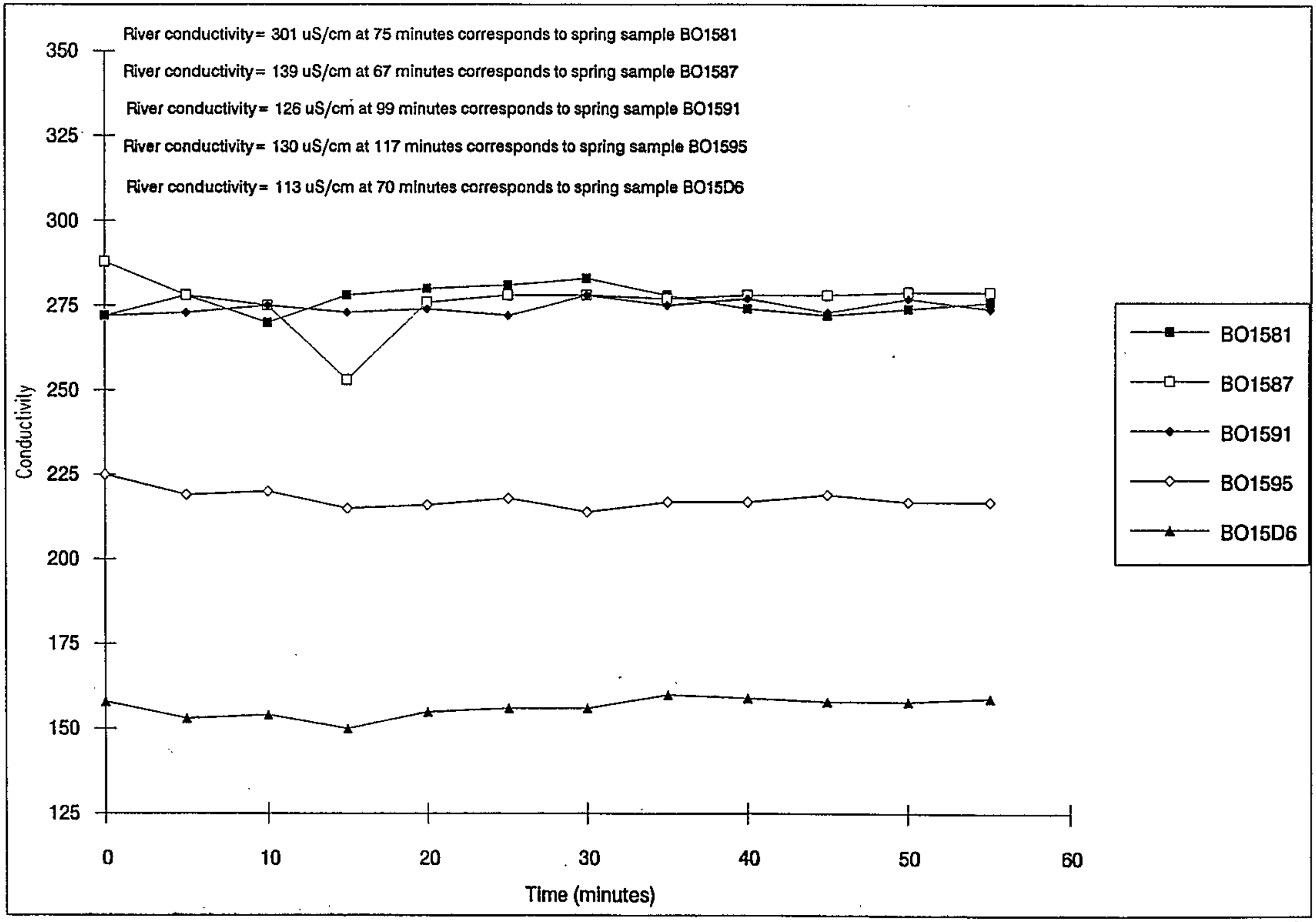

Figure 18. Time vs. Electrical Conductivity, 100-H Area.

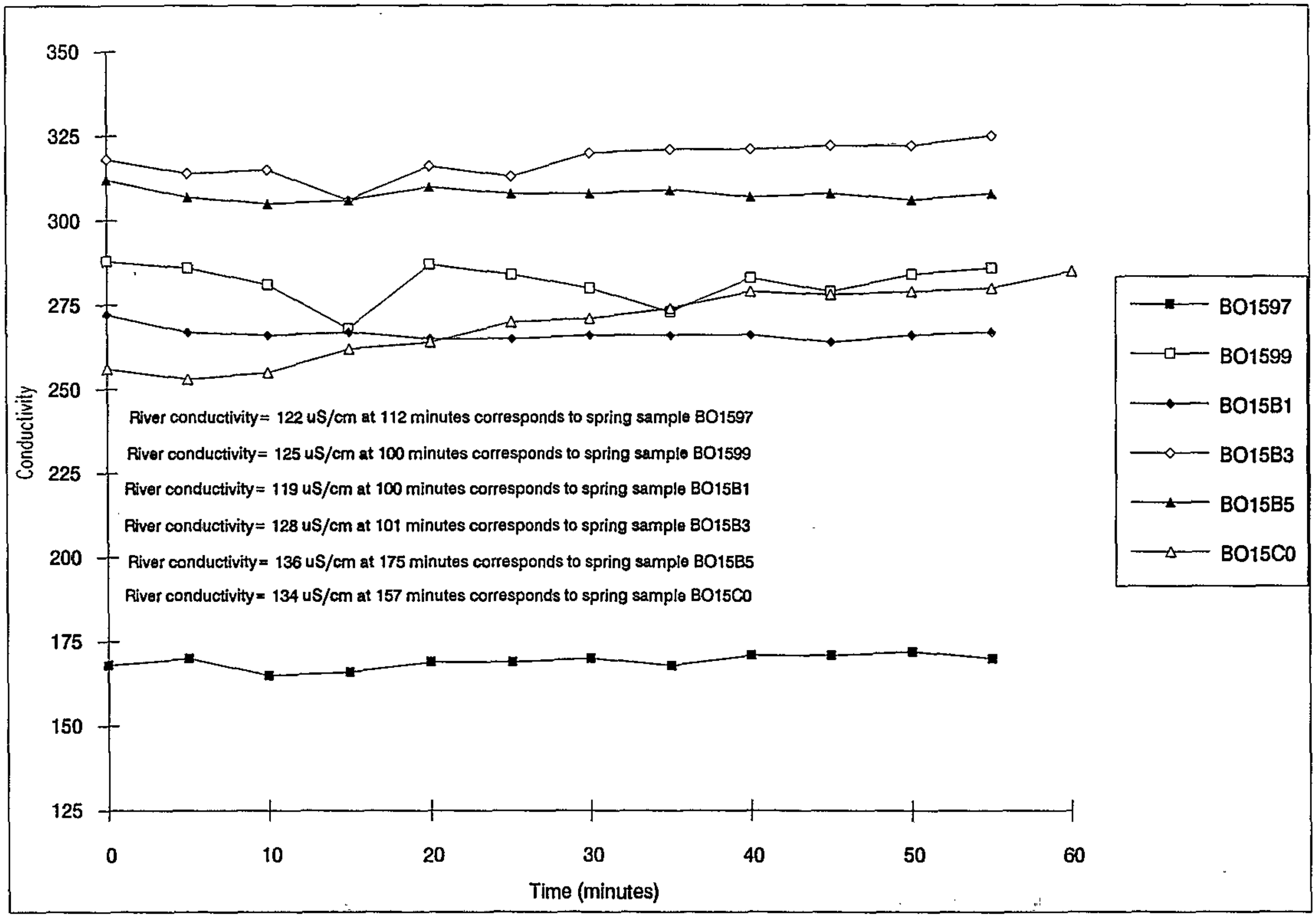

Figure 19. Time vs. Electrical Conductivity, 100-F Area.

9 2 1 2 1 5 1 0 2 0 4

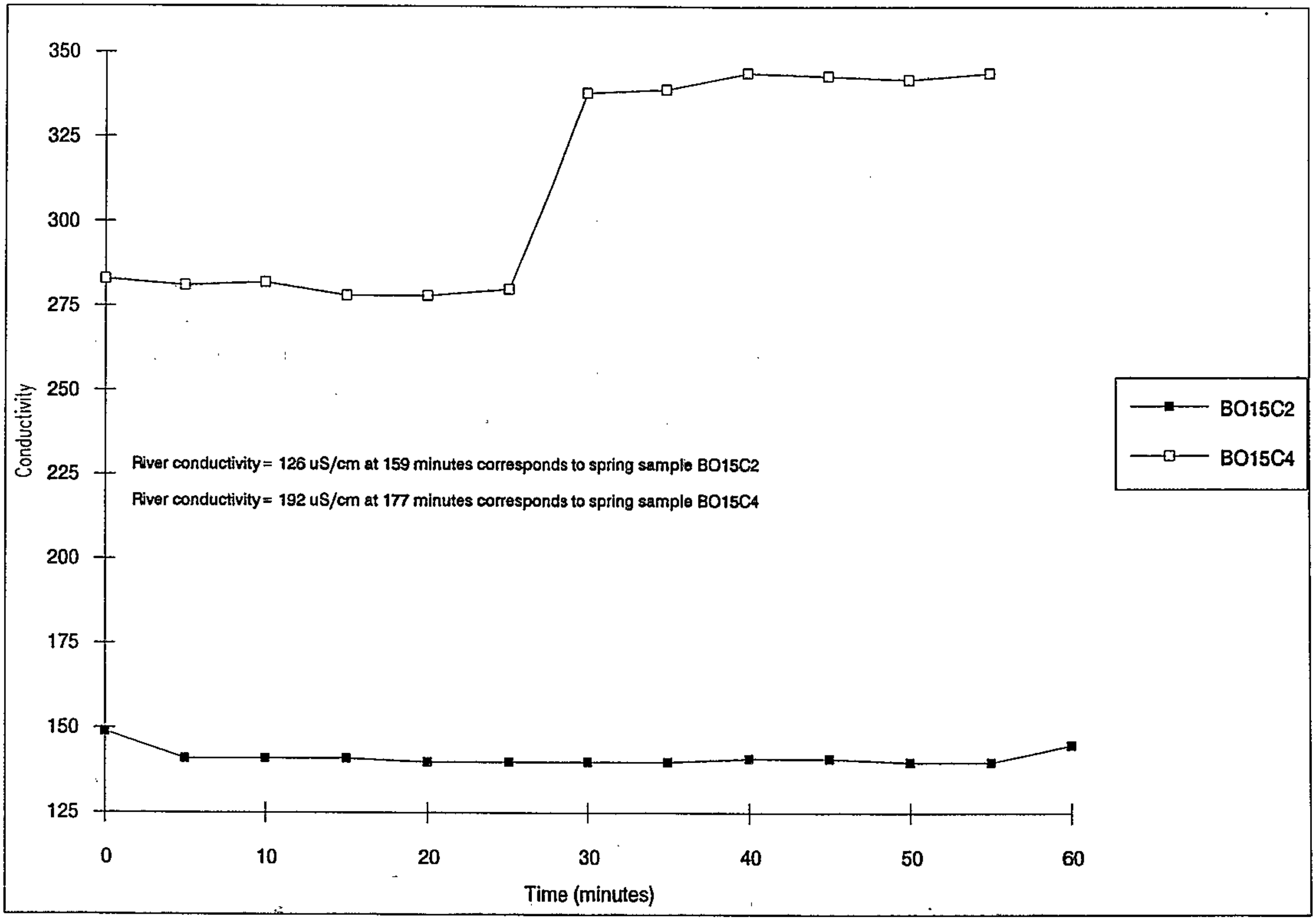

Figure 20. Time vs. Electrical Conductivity, Hanford Townsite.

3.2.5 Quality Control/Quality Assurance

Quality Control/Quality Assurance was accomplished through the collection of duplicate samples at two locations (four samples; two river and two spring). These samples were submitted as blind samples to the laboratory through the normal procedures for sample submission. The analytical results of these duplicate samples are provided along with other analyses in the Appendixes to this report.

3.3 DATA ASSESSMENT

Chemical and radiological data, as well as the onsite measurements, were evaluated to assess contaminant levels. As discussed in Section 3.3.2, field measurements of temperature and conductivity indicate that, in the majority of instances, the samples collected from the springs are interpreted to be representative of groundwater. In a few cases these parameters indicate that a mixture of surface and groundwater may have been sampled. In areas such as 100-N, where large quantities of deionized water have been discharged to the ground, groundwater chemistry may exhibit electrical conductivity intermediate between groundwater and the adjacent Columbia River.

The radiological data derived from analysis of the water and sediment samples were evaluated to assess the relative contribution of radionuclide loading on the Columbia River. Gross alpha and gross beta analyses were taken as overall indicator parameters, no attempt was made to correlate the concentration of indicators with the concentration of specific radionuclides. A general correlation exists for example between the gross beta concentration and the concentration of strontium-90 (^{90}Sr), a beta emitting radionuclide. However, the gross beta value includes all possible beta emitting radionuclides. Concentrations of radionuclides analyzed through the gamma scan are generally reported as 'less than' values, in spite of the fact that many of those numbers are large. No 'less than' values were used in evaluating contaminant contributions.

This report summarizes the data by contaminant type and by sample location (i.e., reactor area). Although drinking water standards (Table 2) are used for comparison, no implication is made that these standards are the sole basis for addressing the impact of contaminant concentrations.

Table 2. Drinking Water Standards for Prime Hanford Contaminants (40 CFR 141).

Tritium	20,000 picocuries per liter (pCi/L)
Strontium-90	8 pCi/L
Chromium	50 ug/L
Nitrate-nitrogen	10 mg/L (45 mg as NO_3)

3.3.1 Primary Contaminants

Contaminants are entering the Columbia River through springs along the Hanford Reach. The majority of the contaminants enter the river from five areas, 100-B, 100-N, 100-D, 100-H, and 100-F. The primary contaminants are tritium (^3H), ^{90}Sr, chromium (Cr), and nitrate (NO_3).

Tritium: ^3H is the most wide spread constituent present. Concentrations of ^3H range from less than 200 pCi/L to a maximum of 24,300 pCi/L. Measured concentrations at or above current drinking water standards are restricted to springs located at 100-B and 100-N areas.

Strontium-90: ^{90}Sr occurs in springs at levels exceeding allowable drinking water standards in the 100-N, 100-H, 100-K, and 100-F areas. Concentrations of ^{90}Sr are near the detection limits in other springs. Concentrations determined through this study ranged from a high of 3,200±70 pCi/L to lows of <0.2 pCi/L.

Strontium-90 was detected in all of the sediment samples. Concentrations ranged from 0.2 picocuries per gram (pCi/g) at 100-H Area to a high of 207 pCi/g at 100-N Area.

Chromium: Concentrations of Cr near or above drinking water standards are restricted to spring samples from the 100-B, 100-D, and 100-H areas. The spring at the 100-D area, for which data are available (123 mg/L), exceeded the drinking water standard by a factor of almost three. Chromium is the primary contaminant identified for the 100-H and 100-D areas (DOE-RL 1990).

Chromium was detected in all the sediment samples. Chromium is a naturally occurring element and is common to sediments derived from basaltic environments such as at the Hanford Site. Chromium levels ranged from a low of 9.1 milligrams per kilogram (mg/kg) to a high of 107 mg/kg. The highest level of Cr in sediments did not correlate with the highest levels found in spring water.

Nitrate: Concentrations of NO_3 ion ranging from 1.6 to 5.5 milligrams per liter (mg/L) were determined to be present in all springs sampled. None of the springs showed concentrations in excess of drinking water standards. Nitrate values reported in this document are as nitrate (NO_3), values should be divided by 4.5 to equal nitrate-nitrogen concentrations.

3.3.2 Spring Discharges by Area

Appendix C provides the chemical data for the springs and associated river samples derived during this study. Appendix D provides the radiological data for those same samples. All the data is provided by sampling location, in downstream order from the 100-B/C Area to the Hanford Townsite.

3.3.2.1 100-B/C Area. Three springs were sampled, but laboratory analytical results have been received for only two sites. Detectable concentrations of Cr [41 and 54 micrograms per liter (μg/L)] along with ^3H (20,600 and 13,000 pCi/L) and total uranium (1.6 and 272 pCi/L) discharge to the river from the 100-B/C Area. Sampling of the Columbia River adjacent to these springs showed concentrations of Cr at 6 μg/L, ^3H at 300 pCi/L, and total uranium at 0.4 pCi/L. Contaminants being discharged to the river coincide with known groundwater contaminants at this location.

Spring temperatures were the highest measured of all the reactor areas, ranging from 20°C to 22°C.

The ^{3}H concentration observed during the 1991 sampling was significantly higher than that earlier reported. Dirkes (1990) reported a ^{3}H concentration of 1,100 pCi/L, while this study determined a concentration 20,600 pCi/L. Nitrate concentrations at this location were reported at 6.7 mg/L versus 2.3 mg/L determined during this study. Differences in concentration are not readily explained, but are probably due to the effects of river stage history immediately preceding sampling for the two sampling periods.

Analyses of sediment samples show that some residual radionuclide contamination exists at the 100-B/C Area. Positive analyses were noted for ^{90}Sr at 0.3 and 0.4 pCi/g, cesium-137 (^{137}Cs) at 0.15 and 0.03 pCi/g along with radium-226 (^{226}Ra) at 0.78 and 0.45 pCi/g, thorium-228 (^{228}Th) at 1.02 and 0.78 pCi/g and thorium-232 (^{232}Th) at 0.96 and 0.67 pCi/g. The ^{226}Ra and ^{228}Th concentrations probably relate to the level of total uranium found in the spring sample analysis.

Nonradiological analyses of the sediments showed no elevated concentrations of metals. Chromium concentrations of 52.1 and 51.7 mg/kg are within the bounds of natural levels.

3.3.2.2 100-K Area. Three springs were sampled. Detectable concentrations of Cr (17, 64.5, and 13.9 µg/L), ^{3}H (1,400, 400 and 8,900 pCi/L), ^{90}Sr (a single detection at 8.8 pCi/L), technetium-99 (^{99}Tc) (a single detection at 5.2 pCi/L) and total uranium (1, 0.24, and 1.1 pCi/L) were found. The springs at 100-K Area discharge at rates significantly below those of other springs sampled. Samples of the Columbia River adjacent to the springs at this location showed ranges in concentration for Cr (2 to 6 µg/L), ^{90}Sr (0.4 to 0.7 pCi/L), ^{99}Tc (single detection at 0.2 pCi/L) and total uranium (0.3 to 0.5 pCi/L). Tritium concentrations were all below the statistically derived concentration.

The flow rate of the upstream springs in the 100-K Area is minimal, this low flow rate is understandable as they appear to be predominantly through the Ringold formation. The fine grained nature of the Ringold Formation accomplishes two things; 1) it provides the maximum time of travel for contaminants, allowing for maximum decay, and 2) the fine grained materials provide the maximum opportunity for adsorption processes to take place.

Water temperature ranged from 15.6°C to 16.7°C for the three springs sampled. Temperatures were constant over the presampling interval at each of the springs. Measurements of pH exhibited the universal lowering with time that is attributed to pH electrode response. Conductivity measurements were within normal variation with the exception of Sample No. B015D2. At this location, the temperature compensation adjustment was changed, thereby affecting the conductivity measurements. Successive measurements after the change remained consistent and constant indicating that the spring chemistry did not change.

The low concentrations of various constituents is compatible with the limited ongoing activities in 100-K Area and the restriction of most groundwater discharge to the Ringold formation. No comparison with analyses of Dirkes (1990) are possible as no springs were located during that effort.

Sediment analyses from the 100-K Area show low concentrations of ^{90}Sr, ranging from 0.2 to 0.6 pCi/g. Cesium-137 concentrations range from 0.148 to 0.214 pCi/g, indicating that this radionuclide has discharged through the springs during the site's history, even though it is not currently detectable in spring discharges. Other radionuclides present in quantifiable amounts include ^{226}Ra (0.73 to 1.02 pCi/g), ^{228}Th (0.79 to 1.52 pCi/g), and ^{232}Th (0.78 to 1.42 pCi/g).

Results of sediment analyses are presented in Appendix E.

3.3.2.3 100-N Area. Five springs were sampled. The springs at 100-N Area were sampled in conjunction with the annual sampling conducted by the 100 Area Environmental Assurance personnel. Sampling was done following the general protocols developed for the overall spring sampling effort while under the direct guidance of 100-N Area Health Physics Technicians for radiation safety procedures. Some deviation from the protocols was allowed to facilitate coordination with 100-N Area personnel. This deviation from procedure was limited to reducing the number of presampling measurements; in all cases measurements were taken toward the end of the 1-hr period. Detectable concentrations of several contaminants were found in the springs at 100-N Area. Chromium was reported at the 2 µg/L detection limit in two springs and at levels ranging from 2.1 to 3.1 µg/L in the others. Gross beta levels ranged from 5 to 6,850 pCi/L in waters from the springs. Tritium concentrations ranged from 3,400 to 24,300 pCi/L. Strontium-90 was detected at concentrations of 3,210 and 395 pCi/L. Technetium-99 concentrations ranged from 2.5 to 6.2 pCi/L. A single detection of antimony-125 (31 pCi/L) was observed.

The 100-N Area springs provided the highest concentrations of radiocontaminants observed during this sampling effort. Nonradiological contaminants were detected at low levels. Although the N-Reactor is the most recently used facility along the river, total uranium concentrations are among the lowest determined. The presence of ^{90}Sr (3,210 pCi/L) in Sample B015C8 at levels well above the drinking water standard and is consistent with results of previous samplings of these springs. Analysis of the spring data shows that the concentrations of contaminants varies along the 100-N Area springs. The furthest upstream sample, Sample B015C8 showed the highest concentration of ^{90}Sr. Sample B015F0, taken approximately 0.2 mi downstream has the highest concentration of ^{3}H.

Analysis of Columbia River water collected adjacent to the 100-N Area springs showed contaminant concentrations significantly below the spring concentrations. Chromium concentrations ranged from 2 to 6 µg/L for river samples. Gross Beta analyses ranged from 1 to 2 pCi/L while ^{3}H ranged from <200 to 800 pCi/L. Results from ^{90}Sr analyses ranged from a <0.8 to 90 pCi/L (Sample B015D5). Three positive analyses for ^{99}Tc ranged from 1.7 to 3.9 pCi/L. A single positive ^{226}Ra analysis of 22.5 pCi/L was determined through the gamma scan. The rapid dispersal of contaminants in the river at 100-N Area can be attributed to the flow characteristics at that location. The river is flowing in a northeasterly direction past 100-N Area, without islands or bank protrusions to deflect the current or cause eddies. The banks are steep, with water reaching depths of up to 10 ft close to shore.

Significant decreases in radionuclide contributions to the Columbia River are noted between those derived during this sampling and those reported by Dirkes (1990). Some constituents have remained constant, while none have increased in concentration. In the spring at River Mile 8.9, gross beta concentrations have been reduced from 13,800 pCi/L to 6,830 pCi/L, a factor of two. Tritium concentrations have reduced from 111,000 pCi/L to 15,900 pCi/L, a factor of nearly seven. Strontium-90 concentrations in 1988 were reported at 6,680 pCi/L, while 1991 concentrations were determined to be 3,210 pCi/L, again a reduction by a factor of about two. Nitrate concentrations have been reduced from 28.6 mg/L in 1988 to 1.4 mg/L in 1991, a factor of almost 20. Similar, yet not as dramatic changes in concentration are noted further downstream. These changes can be partially attributed to the inactive status of the N-Reactor and the near total cut-off of liquid discharges to contaminated cribs and trenches in the 100-N Area and partially to the possible influence of the Columbia River during the period these springs were sampled. Comparison of the sampling results from the 100-N Area springs with shallow groundwater well data will be necessary to fully address the reasons for the lower concentrations of radiocontaminants noted through this study.

The concentration of ^{90}Sr ranged in sediments from less than detectable to 207 pCi/g. Other radionuclides ^{137}Cs, ^{226}Ra, ^{228}Th, and ^{232}Th were within the range present in other reactor area spring sediments. Potassium-40 (^{40}K), a naturally occurring radionuclide was present at an average concentration of 12.7 pCi/g in sediment samples.

Concentrations of analytes in 100-N Area sediments are shown in Appendix E.

3.3.2.4 100-D Area. Two springs were sampled at 100-D Area. At this time the analyses from only one of these springs have been returned. This spring (Sample B01593) showed the highest concentration of Cr (123 µg/L) of all sample locations. Other contaminants detected included ^{3}H at 3,100 pCi/L, ^{90}Sr at 1.8 pCi/L, ^{99}Tc at 4.9 pCi/L, and total uranium at 1 pCi/L. Analysis of Columbia River water at this location showed a Cr concentration of 8.8 µg/L. All other contaminants were below the detection limit.

The springs at 100-D Area showed the second highest temperatures of those springs sampled. The springs were discharging at 18.2°C and 18.9°C.

The pH and conductivity of the springs stabilized after 10 min in both springs. The range of pH was 7.55 to 7.31 between the springs. Conductivity range for the two springs was 268 to 302 µS/cm.

Comparison with concentrations reported in Dirkes (1990) is difficult because of the relatively low concentrations and the statistical nature of radionuclide analyses. Concentrations of ^{3}H were determined to be higher in 1991 than those reported in Dirkes (1990) for the spring at River Mile 11. This spring discharges close to the river level and may well have hydrologic influences affecting the chemistry. Dirkes (1990) did not analyze for Cr at this location.

No analyses of sediment samples collected from the 100-D Area have been received.

3.3.2.5 100-H Area. Five springs were located and sampled at 100-H Area. All of the sampled springs showed Cr contamination, ranging from 15.7 to 47.4 µg/L. Tritium concentrations ranged from 400 to 3,800 pCi/L while ^{90}Sr concentrations ranged from 0.4 to a high of 12.7 pCi/L. Four of the springs had total uranium concentrations of about 1 pCi/L while Sample B01591 had a high of 278 pCi/L. Columbia River samples collected adjacent to the springs were at or very near the detection limits for contaminant species.

The temperature of the springs emanating at the 100-H Area is close to normal groundwater temperatures and ranged from 13.5°C to 16.1°C. Sample B015D6, the furthest downstream, exhibited the highest temperatures. Sample B01587 was the only spring to exhibit a definite increase in temperature during the 1-h presampling monitoring. Temperature rose from 14.4°C to 15.1°C, over a 5-min interval, where it stabilized.

The pH of the individual springs in this area stabilized earlier than any of the other springs, generally within 10 min of the first measurement.

Electrical conductivity measurements were relatively constant during the measurement interval. Samples B01595 and B015D6 exhibited lower electrical conductivity than the more upstream 100-H Area springs. Sample B015D6 had an average electrical conductivity of only 156 µS/cm. This value could be indicative of dilution of groundwater with river water. This possibility is reduced by the parallel high temperature of the spring indicating thermal influences in the groundwater system.

The changes in field-measured parameters in this area indicate the possibility of bank storage influences on the chemical and physical make-up of the springs sampled. While the parameters measured are indicative of the status of discharges on the day sampled, they may not be totally representative of the chemistry following an extended period of low river flow.

Elevated Cr concentrations are consistent with known contamination of the groundwater system at this area (DOE 1990). The level of Cr reaching the river through the springs is at or slightly below the concentrations expected based on historically reported groundwater concentrations.

The concentration of total uranium (278 pCi/L) in spring water from this area is well above the level that was anticipated (Evans et al. 1990). This presence of total uranium in the groundwater is consistent with materials that have entered the groundwater system through operations at 100-H Area.

High NO_3 concentrations are reported for groundwater at 100-H Area and were anticipated from the spring samples collected in this reach. Nitrate concentrations in groundwater at 100-H commonly exceed the drinking water standard of 45 mg/L. All samples collected were below this level by a factor of 10, further indicating the probability of bank storage effecting chemical and radiological concentrations.

Direct comparison with the results reported in Dirkes (1990) is difficult. Sampling of a single spring at River Mile 15 during that study was reported to be influenced by a recent change in river level and the possibility of bank storage influence on spring chemistry. Similar conditions existed during this study.

Sediment samples collected from the springs at 100-H Area showed positive detections of ^{90}Sr for three of the samples. The concentrations were 0.3, 0.2, and 0.9 pCi/g among the lowest of the positive detections for this radionuclide. Cesium-137 was detected in the sediments from all five springs at an averaged concentration of 0.26 pCi/g. Naturally occurring ^{40}K was the most prevalent radioactive component in the sediments, averaging 13.3 pCi/g. Average concentrations for other detected radionuclides were; ^{226}Ra at 0.74 pCi/g, ^{228}Th and ^{232}Th both at 1.03 pCi/g.

Results of sediment analyses are presented in Appendix E.

3.3.2.6 100-F Area. Two springs were sampled adjacent to the 100-F Area and an additional four springs sampled immediately downstream of the area. Concentrations of all constituents were close to the detection limit except for positive values for ^{90}Sr of 46 and 2.5 pCi/L. Sample Number B015B3, collected approximately 2.8 mi downstream had a reported ^{90}Sr concentration of 40 pCi/L. The drinking water standard for ^{90}Sr is 8 pCi/L. Analyses of samples of the Columbia River were all reported as less than the detection limit.

Temperature of the springs at 100-F Area was indicative of mixed water sources, ranging from 16.8°C to 13.8°C. Values remained constant for the entire presampling period. Such a wide range of temperature is unusual for non-thermally altered groundwater. River temperature at the time of sampling ranged from 18.3°C to 20.0°C, respectively. The pH of the springs stabilized after 40 min., and final readings ranged from 7.3 to 7.5. Conductivity measurements indicate possible mixing of groundwater and river water in Sample B01597 with a conductivity of 170 µS/cm and a higher percentage of groundwater contribution in the other springs, ranging from 260 µS/cm to 320 µS/cm.

Direct comparison with Dirkes (1990) is not possible, as no 100-F Area springs were located during that effort and, therefore, were not sampled.

Sediments from springs at 100-F Area showed one positive occurrence of ^{90}Sr at 20 pCi/g (Sample B01597). This sample corresponds with the spring sample that showed a concentration of 46 pCi/L. Cesium-137 was detected at an average concentration of 0.35 pCi/g. Positive detections of europium-155 (^{155}Eu) were found in these spring sediments and ranged from 0.326 to 0.066 pCi/g. Cobalt-60 (^{60}Co) was detected in the gamma scan analyses at levels ranging from 0.06 to 0.25 pCi/g. Average concentrations for other radionuclides were; ^{226}Ra at 0.77 pCi/g, ^{228}Th at 1.24 pCi/g and ^{232}Th at 1.19 pCi/g.

Sediment analyses are presented in Appendix E.

3.3.2.7 Hanford Townsite. Three springs were sampled in the vicinity of the Hanford Townsite. All analyses showed concentrations of potential contaminants at or below the detection limit. Water from the river was at or below the detection limit for suspected contaminants.

Sediment samples from the Hanford Townsite springs showed positive detections of several radionuclides including ^{60}Co, ^{137}Cs, europium-152 (^{152}Eu), ^{155}Eu, ^{226}Ra, ^{228}Th, ^{232}Th, and total uranium. These results are provided in Appendix E.

Dirkes (1990) did not sample these springs at the Hanford Townsite, therefore comparisons are not possible.

4.0 PRELIMINARY ASSESSMENT OF IMPACT

4.1 COLUMBIA RIVER

Contaminants are entering the Columbia River through springs along the Hanford Reach. However, the concentrations of contaminants in river water samples are generally below analytical detection limits. At locations where concentrations are above detection limits, with the exception of specific noted locations, the concentrations are significantly lower than drinking water standards. Samples of all water collected near the Hanford Townsite showed no detectable quantities of radionuclides, and the general chemistry of the river was good. Although the constituents added to the river through the Hanford springs remain in the water, the impact on the quality of the river was not discernible due to the high-dilution factor.

4.2 SPRINGS

Water emanating from springs in the vicinity of retired reactor areas commonly exceeds regulatory (drinking water) standards for one or more contaminants. Depending on river stage, this water either enters the Columbia River directly or within several feet of where it surfaces and is rapidly diluted by the river. The chemistry of the springs sampled during this study cannot be absolutely designated as either groundwater or stored surface water. It is evident that groundwater contaminants enter the river through these springs. The sediments that are influenced by changes in river level serve as a zone of mixing for the groundwater and surface water.

While positive quantities of contaminants were noted entering the river, the mixing of contaminated water with the noncontaminated Columbia River resulted in levels of contaminant concentrations that were below the analytical detection limits used in this study. Work plans for the 100 Areas have called for additional studies to address the impact of groundwater discharges on the Columbia River. This study, as well as earlier studies by Dirkes (1990) and McCormack and Carlile (1984) point out the difficulties associated with relating spring discharge chemistry to river chemistry. It is the authors' impression that time and effort are better spent concentrating on the springs and the complex interrelationship of the groundwater and surface water flow systems than on attempting 'whole river' analyses of groundwater inflow.

5.0 RECOMMENDATIONS

During the course of this effort it became apparent that certain revisions to the requirements and/or procedures could be implemented without sacrificing the quality and acceptability of the resulting data. In addition, certain administrative actions could be taken to supplement and ensure that the effort could proceed more effectively. These recommendations are detailed in the following sections.

5.1 PROCEDURAL CHANGES

5.1.1 Presampling Trend Measurements

Current: The procedure states that measurements of temperature, pH, and electrical conductivity will be taken at 5-min intervals for a period of 1 h prior to the onset of sampling activity.

Proposed: Field measurement of temperature, pH, and conductivity will be taken upon arrival at the sampling site and subsequently during sampling and at the completion of sampling. A minimum of four measurements will be taken and recorded.

Justification: Field practice showed that these measurements did not change appreciably over the period of sampling after stabilization of instruments. The current requirement had an adverse impact on several occasions when sampling was aborted due to rapidly rising river levels. Reducing the amount of time spent at each spring would allow more rapid sampling of the springs and provide a more synoptic view of spring discharges. The understood purpose of this requirement was to allow determination of the influences of bank storage on the effluent water. As measured, these parameters were only of minimal use in determining whether or not the samples represented surface water, groundwater, or a mixture of the two. Detailed and extensive instrumentation of every spring is not justified.

5.1.2 Locating Identification Cairns

Current: The procedure states that one cairn at each site should be placed above the high-water line.

Proposed: Eliminate the necessity for above high-water line placement.

Justification: At the 100-B Area, in some areas downstream of 100-D Area and at 100-K Area, the lateral distance to reach a point above the high-water line is sufficiently far that cairn would be out of sight.

5.1.3 Sediment Sample Depth

Current: Samples of sediments are to be collected from the top 4 in. of sediments at each spring site.

Proposed: Eliminate depth restriction, allowing sediments to be collected from whatever depth is necessary to provide sufficient sample mass.

Justification: The cobbly nature of the typical spring site makes this requirement excessive. Fine-grained sediments collected deeper than 4-in. will be equally representative of potentially contaminated soils at any spring site.

5.1.4 Installation of Well Points

Current: Well points may be installed to enhance the ability to collect spring samples.

Proposed: Eliminate reference to well points.

Justification: Although installing well points may ensure a constant sampling location, such installation is impractical. The extremely cobbly nature of the spring locations makes the possibility of well point installation unrealistic. Gross excavation to improve the spring discharge area proved to be the most practical means of providing a sampling site.

5.1.5 Sample Collection Sequence

Current: Collect sediment sample prior to spring/seep improvement.

Proposed: Allow collection of sediment sample following collection of water samples.

Justification: Difficulties in obtaining sufficient sediment quantities (2 kg) results in high turbidity in the spring water. The ability to defer sediment sampling until after collection of the water will speed the entire sampling process. Stabilization of the sediments at the sampling point will not adversely affect the representativeness of the sediment samples.

5.1.6 Sample Containers

Current: Total activity screening calls for glass or plastic small vial [$\geq$1 milliliters (mL)].

Proposed: Increase the volume required to 500 mL for water and 250 mL for sediment.

Justification: The volume required is dependent the screening laboratory used. The increased container size is sufficient to meet the requirements of all screening laboratories.

5.2 ADMINISTRATIVE/PROCESS CHANGES

5.2.1 Communication

Westinghouse Hanford communication with outside personnel during the collection of the spring sample was limited to a plant radio. Use of or access to a cellular telephone to contact the operators at Priest Rapids Dam or other support personnel would be advantageous.

5.2.2 Sample Refrigeration

Access to a sample-holding refrigerator would significantly affect the cost and time associated with sample preservation. Such a refrigerator could be located at the embarkation point or at a location close to the screening laboratory. Ice would only be needed for cooling immediately following collection and for ultimate shipment. There would be no need to care for samples over weekends and other nonwork periods.

5.2.3 Flow Control

Administrative agreements should be made with the Grant County Public Utility District, the U.S. Army Corps of Engineers and the Bonneville Power Administration to control the flow of the Columbia River during the period of sampling. This control would provide assurance that springs would be available for sampling as required. Overall time and expense of sampling could be reduced by up to 30% if this control was instituted. Attempts to plan and conduct field activities based on projections of flow proved unreliable.

5.2.4 Instruments

Use of a portable data logger to collect pH, temperature, and conductivity data from the springs is recommended.

5.2.5 Absolute Location

During this effort, the boat used had Long Range Navigation onboard, this instrument provided a general latitude and longitude for the sampling location. Handheld Global Positioning Satellite units are currently available that could be used to define actual location to within ±25 ft (7.62 m). Use of Global Positioning Satellite technology would permit rapid, reproducible reduction of sampling locations to the Computer Aided Design mapping system, currently available at the Hanford Site.

5.2.6 Spring Notation

As the springs are sampled over time a great deal of confusion will be generated when attempts are made to correlate analyses from separate sampling episodes. A distinct spring notation system should be developed and implemented. This system should be compatible with the well location and numbering system in use at the Hanford Site.

5.3 SCOPE CHANGES

Changes in the scope of sampling and analysis activities are suggested based on the quantity, quality and usefulness of the data collected during this effort.

5.3.1 Numbers of Springs Sampled

Sampling of springs in the vicinity of the 100 Areas Groundwater Operable Units should be continued. The data derived through a continued monitoring effort can be used to assess the overall impact of remediation efforts. Without sufficient precedent information an analysis of cleanup success will be difficult or impossible to make. For the 100 Areas sampling of the Hanford Townsite is not necessary.

5.3.2 Collection of Near Shore River Samples

Sampling the Columbia River immediately adjacent to the springs should only be done where contaminants are entering the river at levels above some agreed upon level. Based on this study, near shore sampling would be recommended for the 100-N and 100-F areas only.

6.0 REFERENCES

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APPENDIX A

HANFORD REACH SPRING SAMPLING PROCEDURE

HANFORD REACH SPRING SAMPLING

PERFORMANCE PROCEDURE

Prepared by:

IT Corporation
1145 Jadwin Avenue, Suite C
Richland, Washington 99352

Task Order I-91-21
Purchase Order No. MLV-SVV-073751.

For:

Westinghouse Hanford Company

Revision 0
August 30, 1991

Prepared by: Original signed by David Myers Date ______________
David A. Myers
IT Senior Task Manager
Richland, WA

Approved by: Original signed by Richard Mahood Date ______________
Richard O. Mahood
IT Quality Assurance Officer
Richland, WA

Approved by Original signed by Kenneth Porter Date ______________
Kenneth R. Porter
IT WHC Program Manager
Richland, WA

1.0 PURPOSE

This procedure is designed to provide a consistent means of sampling springs/seeps and streams so that the analytical results are indicative of environmental conditions at the sampling point.

2.0 SCOPE

This procedure applies to sampling of springs/seeps and adjacent near-shore waters of the Columbia River and is limited to IT Corp., Westinghouse Hanford and their subcontractors involved in the 100 Area spring sampling effort.

3.0 DEFINITIONS

Spring/seep. An area along the bank of the Columbia River where groundwater is discharging to the surface.

Drive Point. A commercially available device commonly used to create a small diameter well. Drive points are available in a narrow range of diameters (1.25 to 2.5 in.), and are commonly 1.5 to 2.0 ft long.

4.0 RESPONSIBILITIES

Specific individual responsibilities may vary depending on the magnitude of the sampling operation. Personnel will be assigned to the effort and their responsibilities designated by the Field Team Leader. The following responsibility descriptions are presented as general guidelines.

4.1 IT CORP. FIELD TEAM LEADER/COGNIZANT ENGINEER

The Field Team Leader/Cognizant Engineer is responsible for:

- Directing field operations
- Coordinating IT, Westinghouse Hanford, PNL support activities
- Assigning sampler responsibilities
- Maintaining Field Logbook(s)
- Coordinating transportation and shipment of samples
- Acquiring sample numbers from OSM.

4.2 WESTINGHOUSE HANFORD FIELD REPRESENTATIVE

The Westinghouse Hanford Field Representative is responsible for direct interface between subcontractors.

4.3 IT CORP. SAMPLER

The Sampler(s) reports to the Field Team Leader and is responsible for:

- Installation of sample site improvements and location markers
- Completing appropriate forms as directed for each sample
- Ensuring that proper sample containers are used
- Containerizing, labeling, and sealing (e.g., evidence tape) individual water and sediment samples
- Maintaining field custody (in accordance with *Environmental Investigations and Site Characterization Manual* (EII) 5.1 "Chain of Custody" (WHC 1988) for all samples pending transportation to the analytical laboratory and
- Performing decontamination of sampling equipment
- Conducting required field measurements.

5.0 REQUIREMENTS

5.1 SAFETY REQUIREMENTS

All sampling activities shall comply with applicable site-specific Job Safety Analysis (JSA) requirements for the areas being sampled. In addition, a 'tailgate' safety meeting will be held before the beginning of work each day to brief field personnel on specific hazards anticipated for that day's effort. Activity specific safety concerns are detailed in Section 6.0.

5.2 RADIOLOGICAL SAFETY

Sampling activities conducted in areas under radiological control will require a Radiation Work Permit (RWP). Before sampling is initiated a radiological survey shall be made of the immediate vicinity of the site(s) to be sampled to determine site-specific background radiation levels. Sample containers shall be closed and sealed while still inside the posted boundaries of the controlled area. All sampling equipment and samples shall be surveyed by a Health Physics Technician (HPT) and either unconditionally released or appropriately labeled upon removal from the controlled area. Sample containers shall not be permitted to leave the controlled area until exterior surfaces are found to be free of removable radioactive contamination. The determination of the presence or absence of removable radioactive contamination shall be accomplished using standard wipe/counting methods.

During sampling activities all protective clothing and/or waste that are used or generated shall be controlled in a manner that protects it from undue exposure to the elements (wind, rain, etc.) and prevents inadvertent loss of control.

Used protective clothing and waste that are generated during the sampling activities conducted in radiologically controlled areas shall be containerized, surveyed, labeled, and transported to appropriate storage or disposal areas at completion of activities. Upon completion of sampling activities, surface radiological contamination levels shall be determined; radiological contamination levels in excess of pre-sampling levels shall be remediated prior to cessation of activities in that area.

5.3 RECORDS

The Field Team Leader is responsible for processing field generated records in accordance with EII 1.6 "Records Management" (WHC 1988).

5.4 TRAINING

Personnel involved directly in the collection and handling of sediment and water samples shall be trained to meet the requirements of 29CFR1910.120, documentation of such training will be available at the IT Richland Engineering Office. Person(s) in direct control of the watercraft used to transport sampling personnel shall meet all applicable state and federal requirements and the specifications set forth in the Westinghouse Hanford Statement of Work for that subcontract, documentation will be maintained with subcontracts files.

5.5 TIMING

Spring/seep sampling conducted to yield samples representative of true groundwater discharges to the river must be accomplished during periods of near to below average river discharge. Late summer to early winter river flows historically meet this condition. It is expected that sustained 14-d average flows of less than 125,000 ft^3/s will result in effluent groundwater rather than bank storage being the predominant source of spring flow.

6.0 PROCEDURE

6.1 SAMPLE LOCATION MARKING

All sampling locations are to be clearly marked on the shoreline above the high-water line by two markers that form a 'range' defining a line. This will allow individual sampling points to be relocated for any subsequent event.

- The 'range' will be installed so that the spring is on line with the range
- Range markers will be installed above the high water mark
- Markers must be highly visible and durable to resist exposure and weathering. Metal fence posts, painted fluorescent orange, are a type of marker that meet these criteria
- The distance from the marker nearest the river to the sampling point will be measured using either a cloth or steel tape to the nearest 1-ft (30.48 cm) increment and recorded in a controlled logbook
- Where feasible the range markers will driven into the sediments using either a sledge hammer or fence-post driver
- Where posts cannot be driven, they will be installed using a wire mesh-supported cairn

Care should be used in installing the range markers as there is potential danger of pinching of hands during post installation. Leather gloves should be worn during this activity. Proper lifting techniques are essential when securing the markers using the wire-mesh cairn.

6.2 SAMPLE COLLECTION SEQUENCE

Sampling of sediments shall precede spring/seep groundwater sampling when both media are to be sampled at a single site. This is to accommodate the probable necessity of improving individual seeps and springs to direct water to a sampling point.

- Collect sediment sample prior to spring/seep improvement. This will ensure representativeness of the sediment sample
- Spring/seep samples and surface water samples (Columbia River) are to be collected contemporaneously
- Coordinate spring/seep and surface water sampling with sampling of groundwater sampling conducted at nearby monitoring wells if possible
- Due to the nature of the spring discharges, no preferred order of water sample collection is necessary
- Conformance with EII 10.3 "Purgewater Management" (WHC 1988) is not required
- Water samples shall be collected in general conformance with EII 5.8 "Groundwater Sampling" (WHC 1988) Sections 6.4 through 6.8 and Appendix A (other portions of EII 5.8 do not apply to spring/seep sampling)
- Sample Numbers shall be assigned by Westinghouse Hanford OSM.

6.3 COLLECTION OF SEDIMENT SAMPLES

Sediment samples are to be collected from areas where springs/seeps emanate from the riverbank. These sediments are to be used to assess the accumulation of contaminants through sorption processes. For this reason only sediments less than or about 2 mm in diameter are appropriate. Two methods of sample collection are available for gathering these samples; excavation and vacuum extraction. General procedures described in EII 5.2 "Soil and Sediment Sampling (WHC 1988) are to be followed with the following alterations.

6.3.1 Excavation Sampling

- Personnel will don new latex or nitrile gloves prior to each sampling event and between sediment sampling and water sampling activities to reduce potential for cross contamination of samples
- Use a decontaminated (per Section 6.7) stainless steel trowel or similar size implement
- Collect sediments from the vicinity of where the springs/seeps first discharge from the riverbank
- Sediments will be gathered from the surface to a maximum depth of 4 in. and placed in the appropriate container(s)
- Collect approximately 2 kg of sediment
- Note in the field activity daily log or controlled logbook (per Section 6.8) the approximate size of the area sampled to meet the volume requirements
- Decant excess water from the sample container(s)
- Immediately after collection seal, label, and place sample on ice.

6.3.2 Vacuum Sampling via Peristaltic Pump

- Use new C-Flex vacuum/suction tubing at each site
- Work the intake portion of the sampler between the coarse materials so that the fine interstitial materials enter the collector
- Decant water from sample accumulator regularly
- Collect sample from the surface to a maximum depth of 4 in.
- Transfer of the sediments from the collection system to the sample bottles immediately following collection
- Immediately after collection seal, label, and place sample on ice.

6.4 PREPARATION OF SAMPLES FOR OFF-SITE SHIPMENT

Samples transported off the Hanford Site or to uncontrolled areas/facilities on the Hanford Site require radiological release. If the samples cannot be opened for analysis, a representative split (water and sediment) from each site sampled shall be submitted for radiological release counting purposes.

6.5 PREPARATION OF SPRING/SEEP SAMPLING POINT

An initial survey of the known spring/seep areas will be made to ascertain if naturally occurring zones of accumulation are present that permit sample collection without improvement. If no such accumulation zone can be located, improvement of the spring will be necessary. Two methods are acceptable, drive point or surface accumulation area.

6.5.1 Installation of a Drive Point

- Attach short segment of standard steel pipe to the drive point (this serves to protect the point during installation)
- Align the drive point and steel pipe so that they will penetrate the sediments at a moderate angle, e.g. $\leq 20°$ from horizontal, vertical depth of penetration should not exceed 1 ft (30.48 cm)
- Using a sledge hammer or fence-post driver, drive the steel pipe and attached drive point into the riverbank until the screened area is fully covered
- Remove the steel pipe from the drive point
- If needed for sampling, a short length of stainless steel or PVC pipe may be threaded onto end of the drive point to aid sample collection.

Special safety considerations are involved in this method. Extreme care must be taken when installing the drive point into the riverbank. Safety goggles are essential to protect against metal spalls from either the sledge, steel pipe, or the drive point. Hands are potentially subject to impact from the sledge hammer or post driver. Leather gloves should be worn as protection from metal slivers. Footing may be tenuous due to wet and/or slippery surfaces.

6.5.2 Preparation of Surface Accumulation Area

- Select an area where the springs/seeps produce noticeable flow at the surface
- Selectively remove cobbles, boulders, etc., to create an accumulation basin

- Removed sediments may be used to create a dam around the excavated area
- Channel spring/seep discharges to the collection point
- If necessary the accumulation basin may be lined with clean sheet plastic or decontaminated stainless steel bowl.

Special safety considerations are involved in this method. Extreme care must be taken in lifting and moving large rocks. Surfaces at the springs/seeps are likely to be slippery due to the water and due accumulations of algae or slime. Slip, trip, and fall hazards may be present, as well as stress to lower back from frequent lifting under nonideal conditions. Additional hazard may exist due to potential over steepening of the bank and may cause sloughing from above. Caution must be exercised during these activities.

6.5.3 Spring/Seep Sample Collection

- Personnel will don new latex or nitrile gloves prior to each sampling event to reduce the potential for sample cross contamination
- Measure and record temperature, pH, and conductivity of spring discharge for 1 h at 5-min intervals. If the site being sampled is being influenced by direct sunlight, shade the sample site to help stabilize induced thermal variations
- Collect sample directly from the end of drive point or from the end of the stainless steel or PVC pipe attached to the drive point
- The area immediately below the discharge point of the drive point or attached pipe may be modified to facilitate filling of the sample bottles
- Where the above options cannot be used, the water may be discharged into a decontaminated (per Section 6.7.2) stainless steel bowl and then transferred to the sample containers using a peristaltic pump
- In instances where the spring was improved by construction of an accumulation area, samples will be transferred into sample containers by pumping directly from the accumulation area using a peristaltic pump
- Filter the sample collected for ICP metals (filtered)
- Immediately after collection seal label and place sample on ice
- Discard any used flexible tubing between sampling events/locations to prevent possible cross contamination. Segregate discarded tubing by placing in a sealable plastic bag and marking the bag with the sampling location. All wastes, except that generated in areas under radiological control, will be contained and controlled in accordance with EII 4.2 "Interim Control of Unknown, Suspected Hazardous and

Mixed Waste" (WHC 1988). Wastes generated from areas under radiological control will be handled in accordance with Guidelines for the Conduct of Radiological Work (Messmer 1991).

6.6 NEAR-SHORE RIVER WATER SAMPLING

Near-shore river water samples will be collected adjacent to the springs to indicate the impact of spring/seepage zone discharges on river water chemistry. In the event that river discharge is greater than 125,000 ft^3/s and covers the spring, only the river sample will be collected.

6.6.1 Sample Site Location

- Samples will be collected as near to the range line as possible
- All samples will be collected from areas of moving water
- The location of the sampling position will be recorded in the field activity daily log or controlled logbook.

6.6.2 Sample Depth

- Samples will be collected where water depth is less than or equal to 3 ft (91.44 cm), at a maximum distance of less than 0.5 ft (15.24 cm) above the bottom
- Water depth will be determined by use of a wading staff marked in feet and tenths of feet

6.6.3 Sample Collection

Samples may be collected using either of two methods; direct filling sampler or, use of a peristaltic pump.

6.6.3.1 Direct Sampling

- Lower sampler to selected depth
- Allow flow through for minimum of 10 seconds
- Close container while holding at sampling depth
- Transfer the collected sample to the filter apparatus or sample container
- Filter the sample collected for ICP metals (filtered)
- Immediately after collection seal, label and place sample on ice.

6.6.3.2 Peristaltic Pump Sampling

- Determine desired sampling depth (0 to 0.5 ft [15.24 cm] above bottom)
- Attach new C-Flex suction tubing to wading staff at desired depth
- Install tubing on pump according to manufacturers instructions
- Actuate pump and collect samples in appropriate containers
- Filter the sample collected for ICP metals (filtered)
- Immediately after collection seal, label and place sample on ice per EII 5.11 "Sample Packaging and Shipping" (WHC 1988).

Working in and around moving water in the Columbia River creates specific hazard exposures. The buddy system will be used whenever samples are being collected in the river. A life-line will be attached to the in-river sampler and controlled by the on shore 'buddy'. In addition, an inflatable 'Mae West' floatation device will be worn. Hip or chest-high waders shall be worn during sample collection. In no case shall the river be entered while barefoot. Slip, trip, and fall hazards are normal when working in moving water, care must be taken to ensure positive footing. Hypothermia is a hazard.

6.7 ANALYTES, PRESERVATIVES, SAMPLE CONTAINERS AND HOLDING TIMES

All glassware and plasticware used to contain and ship samples shall be purchased 'certified clean'.

6.7.1 Sediment

Sediment samples will be collected and transported in the containers listed in Table 1. Following collection and labeling all sediment samples will be placed in an ice chest and cooled with frozen 'blue ice' or doubly bagged water ice.

6.7.2 Water

Water samples from springs/seeps and the Columbia River will be collected and transported in the containers listed in Table 2. Following collection and labeling all water samples will be placed in an ice chest and cooled with frozen 'blue ice' or doubly bagged water ice.

6.8 DECONTAMINATION OF EQUIPMENT

Decontamination of sampling equipment shall be done in accordance with EII 5.4 "Field Decontamination of Drilling, Well Development and Sampling Equipment" (WHC 1988) and shall consist of the following sections as a minimum:

6.8.1 Sediment sampling equipment

Sediment sampling equipment shall be decontaminated at the start of each day's activity and between sampling locations. Decontamination shall consist of the following:

- Scrubbing the instrument in river water to remove coarse material
- Wash and scrub using Alconox (a tradename of Alconox Incorporated) or equivalent detergent solution
- Rinse twice using commercially available distilled or deionized water
- Wrap in clean plastic wrap pending use at next sample location
- Any flexible tubing used in vacuum system shall be discarded and new tubing used for subsequent sample collection.

6.8.2 Water sampling equipment

Water sampling and filtering equipment shall be decontaminated between sampling locations. Decontamination shall consist of the following:

- Equipment contacting sample shall be rinsed in river water to remove any sediments
- Wash and scrub, if possible, the interior and exterior using Alconox or equivalent detergent solution
- Rinse twice using commercially available distilled or deionized water
- Wrap in clean plastic pending use at next sampling event
- Any flexible tubing used in peristaltic pump system shall be discarded and new tubing used for subsequent sample collection.

6.9 FIELD MEASUREMENTS

Site characteristics shall be recorded in the sampling log or controlled notebook prior to and during the sampling events. A new page is necessary for each sampling location. These measurements consist of the following:

- Record date, time, and names of sample crew members
- Spring Temperature: record temperature to nearest 0.5°C at 5-min intervals for 1 h prior to sampling, then at completion of sampling. If collection from an accumulation area is used, provide shading of that area to limit insolation-induced heating
- Air Temperature: record to nearest 0.5°C once at beginning of sample period and once at end

- Time: record start and finish times for each sampling segment; sediments, spring/seep and river, use 24-h clock and record to nearest minute

- pH: record to nearest 0.1 pH unit at 5-min intervals for 1 h prior to spring sampling and before and following river sampling

  - Calibrate instrument at beginning and completion of each day of field activity using standards pH 4.0, 7.0 and 10

  - Record adjustments on Field Instrument Calibration Log

- Specific Conductivity: record to nearest 10 µS (microseimens) at 5-min intervals for 1 h prior to spring sampling and before and following river sampling

  - Calibrate instrument daily

  - Calibrate using a standard solution of 1,000 µS.

- Unusual Occurrences: record when appropriate

- Flow Rate: record approximate discharge rate of springs/seeps.

  - Where samples are collected through a drive point discharge report as the rate of filling a known volume container (e.g., 1 L/min)

  - Where samples are collected from a surface accumulation area visually estimate the discharge rate.

  - River discharge rate will be determined from discharge records based on time of collection.

- Spring Description: record a physical description of the spring/seep

  - Indicate the appearance of the sediments

  - Note wetted areas above and below the sample point

  - Indicate expanse of discharge area

  - Indicate the size (dimensions) of any accumulation area

  - Note any rise or fall of the river stage over the sampling period and any evidence of recent high water

- River Description: Record a subjective description of river water clarity (clear, colored, muddy, etc.) and other conditions at the time of sampling

- Atmospheric Conditions: Record a simple description of weather conditions from the start of site preparations through completion of sampling

6.10 SAMPLE CONTROL AND SHIPMENT

6.10.1 Sample Packaging and Shipment

Sample packaging and shipment procedures shall be those described in EII 5.11 "Sample Packaging and Shipping".

6.10.2 Chain of Custody

Maintenance of Chain of Custody shall be in accordance with EII 5.1 Chain of Custody (WHC 1988).

7.0 REFERENCES

1. WHC-CM-7-7, EII 4.2. Rev 2, INTERIM CONTROL OF UNKNOWN, SUSPECTED HAZARDOUS AND MIXED WASTE.

2. WHC-CM-7-7, EII 5.1 CHAIN OF CUSTODY.

3. WHC-CM-7-7, EII 5.2. Rev. 3, SOIL AND SEDIMENT SAMPLING

4. WHC-CM-7-7, EII 5.4 Rev 3, FIELD DECONTAMINATION OF DRILLING, WELL DEVELOPMENT AND SAMPLING EQUIPMENT

5. WHC-CM-7-7, EII 5.8, Rev. 1, GROUNDWATER SAMPLING.

6. WHC-CM-7-7, EII 5.11, SAMPLE PACKAGING AND SHIPPING.

7. WHC CM-7-7, EII 10.3 PURGEWATER MANAGEMENT

8. WHC-IP-0718, GUIDELINES FOR THE CONDUCT OF RADIOLOGICAL WORK.

Table 1. Sampling Containers for Sediment Samples.

Analyte	Method	Holding time (months)	Cont./vol
ICP Metals	6010	6	G/120 mℓ
Gross alpha	Lab. SOP	6	G/2 kg of soil (~1000 mℓ)
Gross beta	Lab. SOP	6	
Gamma spec.	Lab. SOP	6	
Total activity	N/A		G or P small vial (≥ 100 mℓ)

Table 2. Sampling Containers, Method Numbers, Holding Times for Water Samples.

Analyte	Method	Holding time	Preserv.	Cont./Vol.
ICP Metals (filtered)	6010	6 months	HNO_3	P/1000 mℓ
ICP Metals (unfiltered)	6010	6 months	HNO_3	P/1000 mℓ
Anions (IC)	300.0	48 hrs	N/A	P/1000 mℓ
Conductivity	9050	28 days		
Alkalinity		14 days		
TDS		7 days		
Turbidity	pH	48 hrs		
	9040	ASAP (upon lab arrival)		
Ammonium		28 days	H_2SO_4	P/250 mℓ
COD		28 days	H_2SO_4	
TOC	9060	28 days	H_2SO_4	Gs/250 mℓ
Gross alpha	Lab. SOP		HNO_3	P/4000 mℓ
Gross beta	Lab. SOP		HNO_3	
Gamma spec.	Lab. SOP	6 months	HNO_3	
Total uranium	Lab. SOP	6 months	HNO_3	G/120 mℓ
Tritium	Lab. SOP	6 months	HNO_3	Gs/250 mℓ
Sr-90	Lab. SOP	6 months	HNO_3	P/1000 mℓ
Tc-99	Lab. SOP	6 months	HNO_3	P/1000 mℓ
Total activity	N/A			G or P small vial (≥ 100 mℓ)

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APPENDIX B

NONCONFORMANCES AND VARIANCES TO APPROVED PROCEDURE

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INTERNATIONAL TECHNOLOGY CORPORATION

NONCONFORMANCE REPORT

PROJECT NO. 199806·121·02

PAGE 1 OF 1

PROJECT NAME Hanford Reach Spring Sampling

DATE: 2-12-92

NONCONFORMANCE: Near-shore river sampling during the Hanford Reach Spring Sampling (September through November 1991) did not use all equipment required in the Hanford Reach Spring Sampling Performance Procedure, Revision 0, dated August 30, 1991. Section 6.6.~~1~~2 requires use of a wading staff marked in feet and tenths of feet to determine sample collection depth.

A wading staff was not used. Instead, the direct sampler was mounted to a aluminum tube. The tube served as a wading staff and to position the sampler at the required depth interval, i.e., less than 0.5 feet above bottom and less than three feet below water level, by mounting the direct filling sampler less than 0.5 feet from the tube end that would be submerged and by marking the tube.

IDENTIFIED BY: Richard Mahood DATE: 2-12-92

CORRECTIVE ACTION REQUIRED: Revise the Hanford Reach Spring Sampling Performance Procedure, Revision 0, dated August 30, 1991 to accommodate field conditions and information gained during the 1991 field season. The procedure should be revised prior to the next sampling period.

TO BE PERFORMED BY: Richard Mahood DATE: 2-12-92

MUST CORRECTION BE VERIFIED? YES X NO

TO BE VERIFIED BY: D.A. Myers PREPARED BY: R. Mahood/F.D. Carter DATE: 2-12-92

CORRECTIVE ACTION TAKEN:

FEB 1992
RECEIVED
IT Corporation
Richland, WA 99352

PERFORMED BY: DATE:

VERIFIED BY: DATE:

CC: Corrective Action Required.

Approved By: [signature] Date: 2/13/92

[signature] Date: 2/12/92

F.D. Carter
QA Manager

INTERNATIONAL TECHNOLOGY CORPORATION

NONCONFORMANCE REPORT

PROJECT NO. 199806.121.02 PAGE 1 OF 1

PROJECT NAME Hanford Reach Spring Sampling DATE: 2-12-92

NONCONFORMANCE: Installation of range markers during Hanford Reach Spring Sampling (September through November 1991) did not completely follow the Hanford Reach Spring Sampling Performance Procedure, Revision 0, dated August 30, 1991. Section 6.1 requires that range markers be installed above the high water mark.

Range markers were installed above the apparent seasonal high water line. However, many of the range markers are located at elevations below the high water line associated with the annual maximum river discharge. Range markers would not be visible from the river if installed above the annual high water line in some sampling locations at the 100-H, 100-F, 100-K, and 100-B/C areas. The annual high water line was indicated by debris entangled in the branches and crowns of trees and shrubs found along the shoreline. Locations of springs were also plotted on 1 to 2000 scale maps to provide a back-up method of locating the springs.

IDENTIFIED BY: Richard Mahood DATE: 2-12-92

CORRECTIVE ACTION REQUIRED: Revise the Hanford Reach Spring Sampling Performance Procedure, Revision 0, dated August 30, 1991 to accommodate field conditions and information gained during the 1991 field season. The revision should incorporate information gained from inspection, after the period of annual maximum flow, of the range markers installed during the 1991 field effort. The revision should be performed prior to the next sampling period.

TO BE PERFORMED BY: Richard Mahood DATE: 2-12-92

MUST CORRECTION BE VERIFIED? YES X NO ____

TO BE VERIFIED BY: D.A. Myers PREPARED BY: R. Mahood/F.D. Carter DATE: 2-12-92

CORRECTIVE ACTION TAKEN:

PERFORMED BY: ____________ DATE: ________

VERIFIED BY: ____________ DATE: ________

CC: Corrective Action Required

Approved By: [signature] Date: 2/13/92

[signature] Date: 2/12/92

F.D. Carter
QA Manager

DOE/RL-92-12

INTERNATIONAL TECHNOLOGY CORPORATION

NONCONFORMANCE REPORT

PROJECT NO. 199806-121-02

PROJECT NAME Hanford Reach Spring Sampling

PAGE 1 OF 1

DATE: 2-12-92

NONCONFORMANCE: Collection of sediment samples during Hanford Reach Spring Sampling (September through November 1991) did not completely follow the Hanford Reach Spring Sampling Performance Procedure, Revision 0, dated August 30, 1991. Section 6.2 requires that sediments be collected before spring water collection, and Section 6.3.1 requires sediments be collected no more than four inches below the surface.

Spring and river water were collected concurrently but before sediment collection. This allowed all samples to be collected as quickly as possible and did not diminish the quality of the samples. Collecting water before sediment reduced the possibility that rising river level would flood the spring during sampling, before all types of samples could be collected. The river water level was found to be capable of rising many feet in a few hours which limited the time available for sampling at a location.

When sampling sediment on shorelines consisting largely of gravel, cobbles, or boulders the fine-grained sediments were collected as much as 12 inches below the surface to obtain the required two kg of fine-grained sediment.

IDENTIFIED BY: Richard Mahood DATE: 2-12-92

CORRECTIVE ACTION REQUIRED: Revise the Hanford Reach Spring Sampling Performance Procedure, Revision 0, dated August 30, 1991 to include information gained during the 1991 field season. The revision should include the order in which water and sediment samples are collected, and modification of the procedure to accommodate field conditions. The revision should be performed prior to the next sampling period.

TO BE PERFORMED BY: Richard Mahood DATE: 2-12-92

MUST CORRECTION BE VERIFIED? YES X NO ____

TO BE VERIFIED BY: D.A. Myers PREPARED BY: R. Mahood/F.D. Carter DATE: 2-12-92

CORRECTIVE ACTION TAKEN:

PERFORMED BY: ________ DATE: ________

VERIFIED BY: ________ DATE: ________

CC: Corrective Action Required

Approved By: [signature] Date: 2/12/92

[signature] Date: 2/12/92

F.D. Carter
QA Manager

9212 5 3 0 2 3 7

INTERNATIONAL TECHNOLOGY CORPORATION

NONCONFORMANCE REPORT

PROJECT NO. 199806.121.02 PAGE 1 OF 1

PROJECT NAME Hanford Reach Spring Sampling DATE: 2-12-92

NONCONFORMANCE: The conductivity meter used during the Hanford Reach Spring Sampling (September through November 1991) was not calibrated at the frequency required in the Hanford Reach Spring Sampling Performance Procedure, Revision 0, dated August 30, 1991. Section 6.9 requires use of a daily calibration using a standard solution of 1000 μS.

Calibration was performed using the required standard, but only on two occasions: on 11-01-91 and 11-24-91. On both occasions the instrument "as found" condition was within 10% of the standard, which was felt to be sufficiently accurate and showed instrument stability over time.

IDENTIFIED BY: Richard Mahood DATE: 2-12-92

CORRECTIVE ACTION REQUIRED: ~~Perform calibration at required frequency.~~

Because the conductivity meter showed stability and because meter readings were only used to show sampling source consistency prior and during sampling, no corrective action for the data obtained is necessary. For future sampling events, a meter with improved temperature correction function should be used.

TO BE PERFORMED BY: N.A. DATE: N.A.

MUST CORRECTION BE VERIFIED? YES ~~X~~ NO ____

TO BE VERIFIED BY: ~~[illegible]~~ PREPARED BY: F.D. Carter DATE: 2/12/92

CORRECTIVE ACTION TAKEN:

PERFORMED BY: ____ DATE: ____

VERIFIED BY: ____ DATE: ____

CC:

Approved By: [signature] Date: 2/13/92

[signature] Date: 2/12/92

F.D. Carter
QA Manager

APPENDIX C

CHEMICAL ANALYSES OF WATER SAMPLES

EXPLANATION OF TERMS

Site Identification: This identifier denotes the specific reactor area or general region of the sampling location.

Sample Type: Identifies the source of the sample, either spring or river

Discharge river/spring (ft^3/s): Identifies the average discharge of the Columbia River for the day of sampling or the estimated discharge of the individual spring at the time of sampling. Discharges are in ft^3/s.

Coordinates E (m)
Coordinates N (m): Identifies the location of the sample location according to the NAD 1983 Washington State South Zone Coordinates in Meters .

River Mile (nearest 0.1 mi.): Identifies the approximate Hanford River Mile. Hanford River Mile 0.0 is at the Vernita Bridge. Measurements are scaled from the 1:2000 maps of the Hanford Site.

Date: Day on which the specific sample was collected.

Time Interval: The sampling interval, starting with the initiation of presampling measurements for the springs. For river samples, the interval denotes the actual time during which the sample was collected.

OSM Sample No.: The sample tracking number assigned to a specific set of samples. Each spring/sediment sample had a single number; the adjacent river sample was assigned a separate number. All numbers were supplied by Westinghouse Hanford OSM.

Q (Qualifier): Qualifier codes were supplied through the data validation process. All data validation was done by Westinghouse Hanford OSM.

U - none detected; numerical value is sample quantitation limit
J - estimated value (less than quatitation limit)
B - analyte found in associated blank as well as in sample
UJ - not detected; quantitation limit is estimated
<blank> - positive

nr: Data not recorded by field sampling team

N/A Data not available from analytical laboratory

Site Identification	100B		100B		100B		100B		100B	
Sample Source	spring		spring		river		river		spring	
Discharge river/spring (cfs)	5.90E-04		5.90E-04		9.35E+04		9.35E+04		3.30E-03	
Coordinates E (m)	564540		564540		564940		564940		564675	
Coordinates N (m)	145275		145275		145350		145350		145275	
River Mile (nearest 0.1 mi.)	3.7		3.7		3.7		3.7		3.8	
Date	9/18/91		9/18/91		9/18/91		9/18/91		9/17/91	
Time Interval	9:45 - 11:45		9:45 - 11:45		10:48 - 11:45		10:48 - 11:45		13:25 - 16:19	
OSM Sample No.	**B01579-f**	Q	**B01579**	Q	**B01580-f**	Q	**B01580**	Q	**B01578-f**	Q
Quality Control Sample										
Aluminum (ug/l)	44.70	U	71.30	U	38.20	B	55.60	U	41.70	U
Antimony (ug/l)	47.00	U	47.00	U	47.00	U	47.00	U	47.00	U
Barium (ug/l)	58.70	B	58.70	B	26.10	B	27.20	B	56.50	B
Berylium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	3.00	U	3.00	U	3.00	U	3.00	U	3.00	U
Calcium (ug/l)	38000.00		38800.00		17300.00		17500.00		44400.00	
Chromium (ug/l)	54.10		27.70	J	6.00	UJ	6.00	UJ	40.60	
Cobalt (ug/l)	8.00	U	8.00	U	8.00	U	8.00	U	8.00	U
Copper (ug/l)	5.00	U	5.00	U	5.00	U	5.00	U	5.00	U
Iron (ug/l)	1550.00		64.90	U	12.00	U	63.60	U	41.80	U
Magnesium (ug/l)	8810.00		9010.00		3920.00	B	3950.00	B	6910.00	
Manganese (ug/l)	46.60		2.00	U	3.70	B	8.60	U	2.00	U
Nickel (ug/l)	130.00		9.00	U	9.00	U	9.00	U	9.00	U
Potassium (ug/l)	3700.00	B	3710.00	B	732.00	B	656.00	B	4440.00	B
Silver (ug/l)	4.00	U	4.00	U	4.00	U	5.50	B	4.00	U
Sodium (ug/l)	10400.00		10600.00		1850.00	J	2080.00	J	9630.00	
Vanadium (ug/l)	8.00	B	6.70	B	5.00	U	5.00	U	5.40	B
Zinc (ug/l)	7.00	UJ	7.00	UJ	7.00	UJ	7.00	UJ	7.00	UJ
TOC (mg/l)			1.3	J			2.4	J		
COD (mg/l)			<60				<60			
Ammonia (mg/l)			<0.5	UJ			<0.5	UJ		
Fluoride (mg/l)			0.20	J			<0.05	J		
Chloride (mg/l)			8.03	J			0.11	J		
Nitrite (mg/l)			<0.05	UJ			<0.05	UJ		
Nitrate (mg/l)			1.62	J			<0.1	J		
Sulfate (mg/l)			38.76	J			2.10	J		
Phosphate (mg/l)			<0.1	UJ			<0.1	UJ		
Elec. Cond. (umho/cm)			287	J			121	J		
pH			7.4				8.09			
TDS (mg/l)			190				64			
Turbidity (mg/l)			<0.2				<0.2			
Alkalinity (mg/l)			99	J			53	J		

Site Identification	100B		100K		100K		100K		100K	
Sample Source	spring		spring		spring		river		river	
Discharge river/spring (cfs)	3.30E-03		2.90E-04		2.90E-04		9.30E+04		9.30E+04	
Coordinates E (m)	564675		567585		567585		567585		567585	
Coordinates N (m)	145275		146210		146210		146210		146210	
River Mile (nearest 0.1 mi.)	3.8		5.6		5.6		5.6		5.6	
Date	9/17/91		9/25/91		9/25/91		9/25/91		9/25/91	
Time Interval	13:25 - 16:19		7:25 - 9:05		7:25 - 9:05		9:15 - 9:50		9:15 - 9:50	
OSM Sample No.	B01578	Q	B01589-f	Q	B01589	Q	B01590-f	Q	B01590	Q
Quality Control Sample										
Aluminum (ug/l)	268.00		17.00	U	37.40	U	17.00	U	97.30	U
Antimony (ug/l)	47.00	U	14.00	U	14.00	U	14.00	U	14.90	U
Barium (ug/l)	64.10	B	38.70	B	38.00	J	24.70	B	27.40	J
Beryllium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	3.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Calcium (ug/l)	43100.00		36500.00		35600.00		17300.00		17600.00	
Chromium (ug/l)	36.90	J	17.40		5.00	U	2.00	U	2.00	U
Cobalt (ug/l)	8.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Copper (ug/l)	5.00	U	2.00	U	2.00	UJ	2.00	U	2.00	UJ
Iron (ug/l)	395.00	U	59.80	B	68.90	U	7.00	U	97.60	B
Magnesium (ug/l)	6770.00		9150.00		8800.00		3820.00	B	3850.00	B
Manganese (ug/l)	6.60	U	1.00	U	3.10	U	1.50	B	8.90	B
Nickel (ug/l)	9.00	U	5.00	U	5.00	U	5.00	U	5.00	U
Potassium (ug/l)	4490.00	B	2630.00	J	2540.00	J	709.00	J	718.00	J
Silver (ug/l)	4.00	U	5.00	U	5.00	UJ	5.00	U	5.00	UJ
Sodium (ug/l)	9620.00		11300.00	J	11000.00	J	1900.00	J	2140.00	J
Vanadium (ug/l)	7.80	B	8.60	U	8.50	U	2.00	U	2.00	U
Zinc (ug/l)	7.00	UJ	5.00	U	5.00	U	5.00	U	6.40	B
TOC (mg/l)	1.4	J			0.50	U			1.5	
COD (mg/l)	<60				<60				<60	
Ammonia (mg/l)	<0.5	UJ			<0.5	UJ			<0.5	UJ
Fluoride (mg/l)	0.15	J			<0.05				0.44	
Chloride (mg/l)	9.65	J			5.94				0.75	
Nitrite (mg/l)	<0.05	UJ			<0.05	UJ			<0.05	UJ
Nitrate (mg/l)	2.26	J			1.47	J			<0.1	UJ
Sulfate (mg/l)	41.29	J			19.16				8.40	
Phosphate (mg/l)	<0.1	UJ			<0.1	UJ			<0.1	UJ
Elec. Cond. (umho/cm)	303	J			296	J			123	J
pH	7.68				7.71				7.89	
TDS (mg/l)	210				182				34	
Turbidity (mg/l)	<0.2				<0.2				<0.2	
Alkalinity (mg/l)	107	J			119	J			52	J

Site Identification	100K		100K		100K		100K		100K	
Sample Source	spring		spring		river		river		spring	
Discharge river/spring (cfs)	1.80E-02		1.80E-02		7.62E+04		7.62E+04		2.20E-02	
Coordinates E (m)	569680		569680		569680		569680		570415	
Coordinates N (m)	148070		148070		148070		148070		148780	
River Mile (nearest 0.1 mi.)	7.4		7.4		7.4		7.4		8.1	
Date	10/16/91		10/16/91		10/16/91		10/16/91		10/18/91	
Time Interval	12:30 - 13:30		12:30 - 13:30		12:40 - 13:26		12:40 - 13:26		14:10 - 16:05	
OSM Sample No.	B015D2-f	Q	B015D2	Q	B015D3-f	Q	B015D3	Q	B015F2-f	Q
Quality Control Sample										
Aluminum (ug/l)	45.00	U	255.00		21.10	U	74.90	U	17.00	U
Antimony (ug/l)	14.00	U	47.00	U	14.00	U	47.00	U	14.00	U
Barium (ug/l)	36.30	B	35.90	B	25.00	B	29.70	B	40.30	B
Berylium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	1.00	U	3.00	U	1.00	U	3.00	U	1.00	U
Calcium (ug/l)	28400.00		27100.00		17500.00		16600.00		33500.00	
Chromium (ug/l)	64.50		68.70		2.00	U	6.00	U	13.90	U
Cobalt (ug/l)	2.00	U	8.00	U	2.00	U	8.00	U	2.00	U
Copper (ug/l)	2.00	U	6.50	B	2.00	U	5.00	U	2.00	U
Iron (ug/l)	45.40	U	243.00		10.50	U	171.00		8.50	U
Magnesium (ug/l)	6560.00	J	6350.00		3890.00	J	3700.00	B	8180.00	J
Manganese (ug/l)	1.00	U	8.70	B	1.50	U	19.60		1.00	U
Nickel (ug/l)	5.00	U	9.00	U	5.00	U	9.00	U	5.00	U
Potassium (ug/l)	1470.00	B	1460.00	B	713.00	B	779.00	B	2530.00	N
Silver (ug/l)	5.00	U	5.50	B	5.00	U	4.00	U	5.00	U
Sodium (ug/l)	3270.00	J	3270.00	J	1670.00	J	1580.00	J	17100.00	J
Vanadium (ug/l)	3.80	U	6.30	B	4.10	U	5.00	U	10.90	U
Zinc (ug/l)	5.00	U	8.70	U	5.00	U	7.00	U	5.00	U
TOC (mg/l)			0.75				1.4			
COD (mg/l)			<60				<60			
Ammonia (mg/l)			<0.5				<0.5			
Fluoride (mg/l)			0.36				0.05			
Chloride (mg/l)			2.61				0.83			
Nitrite (mg/l)			<0.05	UJ			<0.05	UJ		
Nitrate (mg/l)			0.97	J			<0.1	UJ		
Sulfate (mg/l)			29.13				8.97			
Phosphate (mg/l)			<0.1	UJ			<0.1	UJ		
Elec. Cond. (umho/cm)			206.8				113.2			
pH			7.12				7.88			
TDS (mg/l)			126				80			
Turbidity (mg/l)			5.30				1.40			
Alkalinity (mg/l)			68.4	J			53.2	J		

Site Identification	100K		100K		100K		100N		100N	
Sample Source	spring		river		river		spring		spring	
Discharge river/spring (cfs)	2.20E-02		9.08E+04		9.08E+04		2.90E-01		2.90E-01	
Coordinates E (m)	570415		570415		570415		571300		571300	
Coordinates N (m)	148780		148780		148780		149920		149920	
River Mile (nearest 0.1 mi.)	8.1		8.1		8.1		9.0		9.0	
Date	10/18/91		10/18/91		10/18/91		10/15/91		10/15/91	
Time Interval	14:10 - 16:05		15:25 - 15:55		15:25 - 15:55		11:00 - 12:30		11:00 - 12:30	
OSM Sample No.	B015F2	Q	B015F3-f	Q	B015F3	Q	B015C8-f	Q	B015C8	Q
Quality Control Sample										
Aluminum (ug/l)	132.00	U	17.00	U	94.40	U	50.20	U	384.00	
Antimony (ug/l)	47.00	U	30.00	B	47.00	U	14.00	U	14.00	U
Barium (ug/l)	42.10	B	19.60	B	27.20	B	29.60	B	35.30	B
Beryllium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	3.00	U	1.00	U	3.00	U	1.00	U	1.00	U
Calcium (ug/l)	32400.00		17100.00		16400.00		24900.00		25600.00	
Chromium (ug/l)	10.50		2.60	U	6.00	U	2.00	U	2.30	U
Cobalt (ug/l)	8.00	U	2.00	U	8.00	U	2.00	U	2.00	U
Copper (ug/l)	5.00	U	2.00	U	5.00	U	2.00	U	2.10	U
Iron (ug/l)	130.00		7.90	U	130.00		28.10	U	405.00	
Magnesium (ug/l)	8050.00		3780.00	J	3670.00	B	4230.00	B	4410.00	B
Manganese (ug/l)	2.50	B	1.80	U	5.80	B	2.30	U	13.70	U
Nickel (ug/l)	9.00	U	5.00	U	9.00	U	5.00	U	5.00	U
Potassium (ug/l)	2560.00	B	756.00	B	722.00	U	1230.00	J	1270.00	J
Silver (ug/l)	4.00	U	5.00	U	4.00	U	5.00	U	5.00	U
Sodium (ug/l)	17000.00	J	1850.00	J	1660.00	J	2590.00	B	2640.00	B
Vanadium (ug/l)	10.70	B	4.70	U	5.00	U	3.20	U	3.50	U
Zinc (ug/l)	7.00	U	5.00	U	7.00	U	5.00	U	13.40	U
TOC (mg/l)	0.50	U			1.4				0.75	
COD (mg/l)	<60				<60				<60	
Ammonia (mg/l)	<0.5				<0.5				<0.5	
Fluoride (mg/l)	0.28				0.11				0.14	
Chloride (mg/l)	6.01				0.86				1.28	
Nitrite (mg/l)	<0.05	UJ			<0.05	UJ			<0.05	UJ
Nitrate (mg/l)	1.11	J			0.50	J			1.42	J
Sulfate (mg/l)	63.91				9.23				15.96	
Phosphate (mg/l)	<0.1	UJ			<0.1	UJ			<0.1	UJ
Elec. Cond. (umho/cm)	306.4				119.5				148.5	
pH	7.76				7.36				7.72	
TDS (mg/l)	221				89				118	
Turbidity (mg/l)	0.88				1.70				3.4	
Alkalinity (mg/l)	80.8	J			52.3	J			66.5	J

Site Identification	100N		100N		100N		100N		100N	
Sample Source	river		spring		spring		river		river	
Discharge river/spring (cfs)	8.16E+04		5.90E-01		5.90E-01		8.16E+04		8.16E+04	
Coordinates E (m)	571300		571465		571465		571465		571465	
Coordinates N (m)	149920		150150		150150		150150		150150	
River Mile (nearest 0.1 mi.)	9.0		9.1		9.1		9.1		9.1	
Date	10/15/91		10/15/91		10/15/91		10/15/91		10/15/91	
Time interval	11:10 - 12:00		14:02 - 15:07		14:02 - 15:07		14:15 - 14:42		14:15 - 14:42	
OSM Sample No.	B015C9	Q	B015D0-f	Q	B015D0	Q	B015D1-f	Q	B015D1	Q
Quality Control Sample										
Aluminum (ug/l)	60.10	U	48.80	U	314.00		34.40	U	67.70	U
Antimony (ug/l)	14.00	U	14.00	U	14.00	U	14.00	U	14.00	U
Barium (ug/l)	25.90	B	19.60	B	19.60	B	23.90	B	24.10	B
Berylium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Calcium (ug/l)	17200.00		26400.00		26400.00		17000.00		16800.00	
Chromium (ug/l)	2.00	U	2.00	U	2.60	U	2.00	U	2.00	U
Cobalt (ug/l)	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Copper (ug/l)	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Iron (ug/l)	43.10	U	35.50	B	474.00		93.50	U	55.20	U
Magnesium (ug/l)	3810.00	B	4540.00	B	4600.00	B	3770.00	B	3720.00	B
Manganese (ug/l)	5.40	U	1.00	U	14.00	U	2.40	U	5.60	U
Nickel (ug/l)	5.00	U	5.00	U	5.00	U	5.00	U	5.00	U
Potassium (ug/l)	675.00	B	1320.00	J	1410.00	J	658.00	J	707.00	J
Silver (ug/l)	5.00	U	5.00	U	5.00	U	5.00	U	5.00	U
Sodium (ug/l)	1830.00	J	2570.00	J	2560.00	J	1800.00	J	1780.00	J
Vanadium (ug/l)	2.00	U	2.00	U	3.20	U	2.00	U	2.00	U
Zinc (ug/l)	5.00	U	5.00	U	17.50	U	27.20	U	5.00	U
TOC (mg/l)	1.3				0.50	U			1.3	
COD (mg/l)	<60				<60				<60	
Ammonia (mg/l)	<0.5				<0.5				<0.5	
Fluoride (mg/l)	0.13				0.42				0.38	
Chloride (mg/l)	0.86				1.70				0.88	
Nitrite (mg/l)	<0.05	UJ			<0.05	UJ			<0.05	UJ
Nitrate (mg/l)	0.50	J			2.36	J			0.50	J
Sulfate (mg/l)	9.06				11.36				9.10	
Phosphate (mg/l)	<0.1	UJ			<0.1	UJ			<0.1	UJ
Elec. Cond. (umho/cm)	99.6				152.3				98.5	
pH	8.01				7.91				8.24	
TDS (mg/l)	75				120				70	
Turbidity (mg/l)	1.2				4.3				0.90	
Alkalinity (mg/l)	53.2	J			72.2	UJ			55.1	J

Site Identification	100N		100N		100N		100N		100N	
Sample Source	spring		spring		river		river		spring	
Discharge river/spring (cfs)	2.20E-02		2.20E-02		9.08E+04		9.08E+04		4.50E-03	
Coordinates E (m)	571480		571480		571480		571480		571500	
Coordinates N (m)	150170		150170		150170		150170		150185	
River Mile (nearest 0.1 mi.)	9.2		9.2		9.2		9.2		9.2	
Date	10/18/91		10/18/91		10/18/91		10/18/91		10/18/91	
Time Interval	12:12 -13:28		12:12 -13:28		12:37 - 12:50		12:37 - 12:50		10:30 - 11:30	
OSM Sample No.	B015F0-f	Q	B015F0	Q	B015F1-f	Q	B015F1	Q	B015D8-f	Q
Quality Control Sample										
Aluminum (ug/l)	89.00	U	127.00	U	17.00	U	62.20	U	17.00	U
Antimony (ug/l)	14.00	U	47.00	U	14.00	U	47.00	U	14.00	U
Barium (ug/l)	23.40	B	29.70	B	24.60	B	29.70	B	30.40	B
Beryllium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	1.00	U	3.00	U	1.00	U	3.00	U	1.00	U
Calcium (ug/l)	21700.00		20800.00		17500.00		16600.00		22400.00	
Chromium (ug/l)	2.40	U	6.00	U	2.00	U	6.00	U	3.10	U
Cobalt (ug/l)	2.00	U	8.00	U	2.00	U	8.00	U	2.00	U
Copper (ug/l)	2.00	U	5.00	U	2.00	U	5.00	U	2.00	U
Iron (ug/l)	126.00		138.00		16.60	U	329.00		7.00	U
Magnesium (ug/l)	5570.00	J	5340.00		3860.00	J	3690.00	B	5970.00	J
Manganese (ug/l)	1.40	U	6.40	B	1.00	U	4.40	B	1.00	U
Nickel (ug/l)	5.00	U	9.00	U	5.00	U	9.00	U	5.00	U
Potassium (ug/l)	2260.00	B	2050.00	B	683.00	B	665.00	U	2230.00	B
Silver (ug/l)	5.00	U	4.00	U	5.00	U	4.00	U	5.00	U
Sodium (ug/l)	4170.00	J	4060.00	J	1800.00	J	1610.00	J	4620.00	J
Vanadium (ug/l)	16.50	U	15.30	B	2.60	U	5.00	U	15.00	U
Zinc (ug/l)	5.00	U	7.00	U	24.40	U	7.00	U	5.00	U
TOC (mg/l)			0.50	U			1.1			
COD (mg/l)			<60				<60			
Ammonia (mg/l)			<0.5				<0.5			
Fluoride (mg/l)			0.16				0.41			
Chloride (mg/l)			1.77				0.86			
Nitrite (mg/l)			<0.05	UJ			<0.05	UJ		
Nitrate (mg/l)			1.63	J			0.50	J		
Sulfate (mg/l)			14.23				8.88			
Phosphate (mg/l)			<0.1	UJ			<0.1	UJ		
Elec. Cond. (umho/cm)			167.2				117.1			
pH			7.75				7.83			
TDS (mg/l)			114				81			
Turbidity (mg/l)			1.50				1.80			
Alkalinity (mg/l)			64.6	J			52.3	J		

Site identification	100N		100N		100N		100N		100N	
Sample Source	spring		river		river		spring		spring	
Discharge river/spring (cfs)	4.50E-03		9.08E+04		9.08E+04		2.20E-02		2.20E-02	
Coordinates E (m)	571500		571500		571500		571680		571680	
Coordinates N (m)	150185		150185		150185		150465		150465	
River Mile (nearest 0.1 mi.)	9.2		9.2		9.2		9.4		9.4	
Date	10/18/91		10/18/91		10/18/91		10/17/91		10/17/91	
Time Interval	10:30 - 11:30		10:41 - 11:09		10:41 - 11:09		10:05 - 11:45		10:05 - 11:45	
OSM Sample No.	B015D8	Q	B015D9-f	Q	B015D9	Q	BO15D4-f	Q	B015D4	Q
Quality Control Sample										
Aluminum (ug/l)	177.00	U	17.00	U	60.40	U	17.00	U	45.30	U
Antimony (ug/l)	47.00	U	14.00	U	47.00	U	15.60	B	47.00	U
Barium (ug/l)	33.40	B	24.50	B	29.70	B	26.20	B	29.70	B
Berylium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	3.00	U	1.00	U	3.00	U	1.00	U	3.00	U
Calcium (ug/l)	21400.00		17400.00		16600.00		21000.00		19900.00	
Chromium (ug/l)	6.00	U	2.00	U	6.00	U	2.10	U	6.00	U
Cobalt (ug/l)	8.00	U	2.00	U	8.00	U	2.00	U	8.00	U
Copper (ug/l)	5.00	U	2.00	U	5.00	U	2.00	U	5.00	U
Iron (ug/l)	202.00		7.00	U	43.90	U	13.30	U	58.10	U
Magnesium (ug/l)	5810.00		3850.00	J	3720.00	B	4830.00	J	4650.00	B
Manganese (ug/l)	10.80	B	1.00	U	4.40	B	1.00	U	2.00	U
Nickel (ug/l)	9.00	U	5.00	U	9.00	U	5.00	U	9.00	U
Potassium (ug/l)	2180.00	B	688.00	B	703.00	U	1650.00	B	1590.00	B
Silver (ug/l)	4.00	U	5.00	U	4.00	U	5.00	U	4.00	U
Sodium (ug/l)	4510.00	J	1710.00	J	1680.00	J	2970.00	J	2880.00	J
Vanadium (ug/l)	15.30	B	3.50	U	5.00	U	10.60	U	9.70	B
Zinc (ug/l)	8.70	U	5.00	U	7.00	U	5.00	U	7.00	U
TOC (mg/l)	0.50	U			1.11				0.65	
COD (mg/l)	<60				<60				<60	
Ammonia (mg/l)	<0.5				<0.5				<0.5	
Fluoride (mg/l)	0.16				0.13				0.11	
Chloride (mg/l)	1.93				0.86				1.49	
Nitrite (mg/l)	<0.05	UJ			<0.05	UJ			<0.05	UJ
Nitrate (mg/l)	1.78	J			0.53	J			1.28	J
Sulfate (mg/l)	15.89				9.14				11.91	
Phosphate (mg/l)	<0.1	UJ			<0.1	UJ			<0.1	UJ
Elec. Cond. (umho/cm)	172.6				118.2				144.2	
pH	7.73				7.90				7.64	
TDS (mg/l)	130				72				90	
Turbidity (mg/l)	6.20				2.60				1.20	
Alkalinity (mg/l)	66.5	J			53.2	J			62.7	J

Site Identification	100N		100N		100D		100D		100D	
Sample Source	river		river		spring		spring		river	
Discharge river/spring (cfs)	1.16E+05		1.16E+05		2.90E-04		2.90E-04		9.48E+04	
Coordinates E (m)	571680		571680		571597		571597		573597	
Coordinates N (m)	150465		150465		152470		152470		152470	
River Mile (nearest 0.1 mi.)	9.4		9.4		11.0		11.0		11.0	
Date	10/17/91		10/17/91		9/26/91		9/26/91		9/26/91	
Time interval	10:30 - 11:22		10:30 - 11:22		9:25 - 10:55		9:25 - 10:55		10:55 - 11:15	
OSM Sample No.	B015D5-f	Q	B015D5	Q	B01593-f	Q	B01593	Q	B01594-f	Q
Quality Control Sample										
Aluminum (ug/l)	20.00	U	42.30	U	17.00	U	77.00	B	18.20	B
Antimony (ug/l)	14.00	U	47.00	U	14.00	U	47.00	U	14.00	U
Barium (ug/l)	25.00	B	29.70	B	53.20	J	55.40	B	24.40	B
Beryllium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	1.00	U	3.00	U	1.00	U	3.00	U	1.00	U
Calcium (ug/l)	17200.00		16400.00		43300.00		42900.00		16900.00	
Chromium (ug/l)	2.00	U	6.00	U	123.00		124.00		2.40	B
Cobalt (ug/l)	2.00	U	8.00	U	2.00	U	8.00	U	2.00	U
Copper (ug/l)	2.00	U	5.00	U	3.10	U	5.00	U	2.00	U
Iron (ug/l)	11.30	U	47.00	U	7.00	U	72.10	J	22.90	B
Magnesium (ug/l)	3810.00	J	3660.00	B	7170.00		7140.00		3770.00	B
Manganese (ug/l)	1.00	U	4.80	B	1.00	U	4.30	B	1.00	U
Nickel (ug/l)	5.00	U	9.00	U	5.00	U	9.00	U	5.00	U
Potassium (ug/l)	675.00	B	698.00	U	2570.00	B	2630.00	B	653.00	J
Silver (ug/l)	5.00	U	4.00	U	5.00	U	4.00	U	5.00	U
Sodium (ug/l)	1760.00	J	1600.00	J	5740.00	J	5760.00	J	1720.00	J
Vanadium (ug/l)	3.20	U	5.00	U	2.80	U	5.00	U	2.00	U
Zinc (ug/l)	5.00	U	7.00	U	7.00	B	8.40	B	5.00	U
TOC (mg/l)			1.3				1.6			
COD (mg/l)			<60				<60			
Ammonia (mg/l)			<0.5				<0.5	UJ		
Fluoride (mg/l)			0.38				0.40			
Chloride (mg/l)			0.87				20.16			
Nitrite (mg/l)			<0.05	UJ			<0.05	UJ		
Nitrate (mg/l)			0.49	J			3.99	J		
Sulfate (mg/l)			8.85				44.43			
Phosphate (mg/l)			<0.1	UJ			<0.1	UJ		
Elec. Cond. (umho/cm)			114.9				308	J		
pH			7.85				7.49			
TDS (mg/l)			70				246			
Turbidity (mg/l)			1.20				2.00			
Alkalinity (mg/l)			53.2	J			71	J		

Site Identification	100D		100H		100H		100H		100H	
Sample Source	river		spring		spring		river		river	
Discharge river/spring (cfs)	9.48E+04		1.20E-03		1.20E-03		8.24E+04		8.24E+04	
Coordinates E (m)	573597		577080		577080		577080		577080	
Coordinates N (m)	152470		153770		153770		153770		153770	
River Mile (nearest 0.1 mi.)	11.0		14.3		14.3		14.3		14.3	
Date	9/26/91		9/20/91		9/20/91		9/20/91		9/20/91	
Time Interval	10:55 - 11:15		9:15 - 11:17		9:15 - 11:17		10:30 - 11:17		10:30 - 11:17	
OSM Sample No.	B01594	Q	B01581-f	Q	B01581	Q	B01582-f	Q	B01582	Q
Quality Control Sample										
Aluminum (ug/l)	58.80	U	31.00	U	169.00	B	31.00	U	115.00	B
Antimony (ug/l)	14.00	U	47.00	U	47.00	U	47.00	U	47.00	U
Barium (ug/l)	26.00	J	40.80	B	41.90	B	25.80	J	31.10	B
Beryllium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	1.00	U	3.00	U	3.00	U	3.00	U	3.00	U
Calcium (ug/l)	17300.00		38900.00		38400.00		17600.00		17400.00	
Chromium (ug/l)	8.80	U	43.30		46.30		6.00	U	6.00	U
Cobalt (ug/l)	2.00	U	8.00	U	8.00	U	8.00	U	8.00	U
Copper (ug/l)	2.00	UJ	5.00	UJ	5.00	UJ	5.00	UJ	5.00	UJ
Iron (ug/l)	102.00		39.30	B	223.00		12.00	U	158.00	
Magnesium (ug/l)	3790.00	B	8690.00		8650.00		3970.00	B	3950.00	B
Manganese (ug/l)	7.20	U	2.00	U	11.80	B	2.00	U	12.40	B
Nickel (ug/l)	5.00	U	9.00	U	9.00	U	9.00	U	9.00	U
Potassium (ug/l)	675.00	J	2830.00	B	2790.00	B	665.00	B	677.00	B
Silver (ug/l)	5.00	UJ	4.00	U	4.00	U	4.00	U	4.00	U
Sodium (ug/l)	1740.00	J	9250.00		9310.00		1830.00	B	2030.00	B
Vanadium (ug/l)	2.70	U	7.10	B	6.70	B	5.00	U	5.00	U
Zinc (ug/l)	6.40	B	7.00	U	7.00	U	7.00	U	7.00	U
TOC (mg/l)	1.8				0.74				1.61	
COD (mg/l)	<60				<60				<60	
Ammonia (mg/l)	<0.5	UJ			<0.5	UJ			<0.5	UJ
Fluoride (mg/l)	0.42				0.17	J			0.15	J
Chloride (mg/l)	0.74				9.30	J			0.99	J
Nitrite (mg/l)	<0.05	UJ			<0.05	UJ			<0.05	UJ
Nitrate (mg/l)	<0.1	J			4.58	J			0.54	J
Sulfate (mg/l)	8.54				45.74	J			9.65	J
Phosphate (mg/l)	<0.1	UJ			<0.1	UJ			<0.1	UJ
Elec. Cond. (umho/cm)	122	J			291	J			123	J
pH	7.97				7.57				8.10	
TDS (mg/l)	90				207				70	
Turbidity (mg/l)	<0.2				1.3				1.3	
Alkalinity (mg/l)	51	J			79	J			56	J

Site Identification	100H		100H		100H		100H		100H	
Sample Source	spring		spring		river		river		spring	
Discharge river/spring (cfs)	nr		nr		8.24E+04		8.24E+04		1.80E-03	
Coordinates E (m)	577255		577255		577255		577255		577330	
Coordinates N (m)	153660		153660		153660		153660		153615	
River Mile (nearest 0.1 mi.)	14.4		14.4		14.4		14.4		14.5	
Date	9/20/91		9/20/91		9/20/91		9/20/91		9/25/91	
Time Interval	11:48 - 13:40		11:48 - 13:40		12:55 - 13:20		12:55 - 13:20		11:22 - 13:00	
OSM Sample No.	B01587-f	Q	B01587	Q	B01588-f	Q	B01588	Q	B01591-f	Q
Quality Control Sample										
Aluminum (ug/l)	31.00	U	77.00	B	38.50	B	69.60	B	137.00	B
Antimony (ug/l)	47.00	U	47.00	U	47.00	U	47.00	U	14.00	U
Barium (ug/l)	32.20	B	33.30	B	29.00	B	29.00	B	27.90	B
Beryllium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	3.00	U	3.00	U	3.00	U	3.00	U	1.00	U
Calcium (ug/l)	36700.00		38500.00		17200.00		16900.00		34900.00	
Chromium (ug/l)	46.90		46.90		6.00	U	6.00	U	47.40	
Cobalt (ug/l)	8.00	U	8.00	U	8.00	U	8.00	U	2.00	U
Copper (ug/l)	5.00	UJ	5.00	UJ	5.00	UJ	5.00	UJ	2.00	U
Iron (ug/l)	39.80	B	114.00		35.40	B	115.00		137.00	
Magnesium (ug/l)	8650.00		9090.00		3910.00	B	3790.00	B	8760.00	
Manganese (ug/l)	2.00	U	2.50	B	2.00	U	8.20	B	1.00	U
Nickel (ug/l)	9.00	U	9.00	U	9.00	U	9.00	U	5.00	U
Potassium (ug/l)	1790.00	B	1710.00	B	723.00	B	627.00	B	3430.00	J
Silver (ug/l)	4.00	U	4.00	U	4.00	U	4.00	U	5.00	U
Sodium (ug/l)	10500.00		11000.00		1760.00	B	1870.00	B	11000.00	J
Vanadium (ug/l)	5.00	U	5.00	U	5.00	U	5.00	U	6.70	U
Zinc (ug/l)	7.00	U	7.00	U	7.00	U	7.00	U	6.00	B
TOC (mg/l)			0.94				1.5			
COD (mg/l)			<60				<60			
Ammonia (mg/l)			<0.5	UJ			<0.5	UJ		
Fluoride (mg/l)			0.18	J			0.44	J		
Chloride (mg/l)			8.36	J			0.79	J		
Nitrite (mg/l)			<0.05	UJ			<0.05	UJ		
Nitrate (mg/l)			4.57	J			<0.1	UJ		
Sulfate (mg/l)			46.65	J			8.57	J		
Phosphate (mg/l)			<0.1	UJ			<0.1	UJ		
Elec. Cond. (umho/cm)			293	J			124	J		
pH			7.26				8.10			
TDS (mg/l)			228				27			
Turbidity (mg/l)			1.0				0.3			
Alkalinity (mg/l)			82	J			53	J		

Site Identification	100H		100H		100H		100H		100H	
Sample Source	spring		river		river		spring		spring	
Discharge river/spring (cfs)	1.80E-03		9.09E+04		9.09E+04		3.00E-04		3.00E-04	
Coordinates E (m)	577330		577330		577330		577885		577885	
Coordinates N (m)	153615		153615		153615		153160		153160	
River Mile (nearest 0.1 mi.)	14.5		14.5		14.5		14.9		14.9	
Date	9/25/91		9/25/91		9/25/91		9/26/91		9/26/91	
Time Interval	11:22 - 13:00		13:00 - 13:25		13:00 - 13:25		12:05 - 13:35		12:05 - 13:35	
OSM Sample No.	B01591	Q	B01592-f	Q	B01592	Q	B01595-f	Q	B01595	Q
Quality Control Sample										
Aluminum (ug/l)	677.00		17.00	U	109.00	U	17.00	U	413.00	
Antimony (ug/l)	14.00	U	14.00	U	15.50	U	14.00	U	14.00	U
Barium (ug/l)	37.30	J	26.00	B	28.80	J	42.90	B	54.00	J
Beryllium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Calcium (ug/l)	35200.00		17300.00		17800.00		28800.00		30500.00	
Chromium (ug/l)	51.60		2.00	U	2.00	U	21.20		35.30	
Cobalt (ug/l)	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Copper (ug/l)	2.00	UJ	2.00	U	2.00	UJ	2.00	U	2.00	UJ
Iron (ug/l)	924.00		7.00	U	136.00		13.40	B	792.00	
Magnesium (ug/l)	8500.00		3840.00	B	3920.00	B	6570.00		6800.00	
Manganese (ug/l)	37.90		1.00	U	10.60	B	2.90	B	31.00	
Nickel (ug/l)	5.00	U	5.00	U	5.00	U	5.00	U	6.00	B
Potassium (ug/l)	3340.00	J	739.00	J	788.00	J	2450.00	J	2530.00	J
Silver (ug/l)	5.00	UJ	5.00	U	5.00	UJ	5.00	U	5.00	UJ
Sodium (ug/l)	10900.00	J	1860.00	J	2130.00	J	7460.00	J	7650.00	J
Vanadium (ug/l)	10.40	U	2.00	U	2.90	U	2.40	U	7.20	U
Zinc (ug/l)	27.30		8.00	B	13.60	B	5.00	U	32.10	
TOC (mg/l)	0.74				1.8				0.84	
COD (mg/l)	<60				<60				<60	
Ammonia (mg/l)	<0.5	UJ			<0.5	UJ			<0.5	UJ
Fluoride (mg/l)	0.21				0.45				0.20	
Chloride (mg/l)	6.43				0.75				2.72	
Nitrite (mg/l)	<0.05	UJ			<0.05	UJ			<0.05	UJ
Nitrate (mg/l)	4.35	J			<0.1	UJ			1.97	J
Sulfate (mg/l)	38.23				8.60				21.24	
Phosphate (mg/l)	<0.1	UJ			<0.1	UJ			<0.1	UJ
Elec. Cond. (umho/cm)	255	J			120	J			226	J
pH	7.37				7.90				7.47	
TDS (mg/l)	188				79				122	
Turbidity (mg/l)	<0.2				<0.2				<0.2	
Alkalinity (mg/l)	80	J			51	J			87	J

Site Identification	100H		100H		100H		100H		100H	
Sample Source	river		river		spring		spring		river	
Discharge river/spring (cfs)	9.48E+04		9.48E+04		4.70E-03		4.70E-03		8.75E+04	
Coordinates E (m)	577885		577885		578235		578235		578235	
Coordinates N (m)	153160		153160		152660		152660		152660	
River Mile (nearest 0.1 mi.)	14.9		14.9		15.3		15.3		15.3	
Date	9/26/91		9/26/91		10/21/91		10/21/91		10/21/91	
Time Interval	14:00 - 14:30		14:00 - 14:30		11:35 - 13:10		11:35 - 13:10		12:38 - 13:10	
OSM Sample No.	B01596-f	Q	B01596	Q	B015D6-f	Q	B015D6	Q	B015D7-f	Q
Quality Control Sample										
Aluminum (ug/l)	17.00	U	60.90	U	31.00	U	104.00	U	370.00	
Antimony (ug/l)	14.00	U	14.00	U	47.00	U	47.00	U	47.00	U
Barium (ug/l)	24.40	B	26.30	J	25.00	B	22.50	B	35.00	B
Berylium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	1.00	U	1.00	U	3.00	U	3.00	U	3.00	U
Calcium (ug/l)	16800.00		17500.00		23700.00		24100.00		16700.00	
Chromium (ug/l)	2.00	U	2.00	U	15.70		20.90		6.00	U
Cobalt (ug/l)	2.00	U	2.00	U	8.00	U	8.00	U	8.00	U
Copper (ug/l)	2.00	U	2.00	UJ	5.00	U	5.00	U	5.00	U
Iron (ug/l)	7.00	U	83.40	U	21.30	U	144.00		415.00	
Magnesium (ug/l)	3720.00	B	3820.00	B	4240.00	B	4480.00	B	4220.00	B
Manganese (ug/l)	1.00	U	8.00	U	2.00	U	4.40	B	3.20	B
Nickel (ug/l)	5.00	U	5.00	U	9.00	U	9.00	U	9.00	U
Potassium (ug/l)	625.00	J	655.00	J	1100.00	B	1230.00	B	952.00	B
Silver (ug/l)	5.00	U	5.00	UJ	4.00	U	4.00	U	4.00	U
Sodium (ug/l)	1670.00	J	1980.00	J	3380.00	J	3470.00	J	1610.00	J
Vanadium (ug/l)	2.00	U	2.60	B	5.00	U	5.00	U	5.00	U
Zinc (ug/l)	261.00		8.00	B	7.00	U	7.00	U	7.00	U
TOC (mg/l)			1.4				0.83			
COD (mg/l)			<60				<60			
Ammonia (mg/l)			<0.5	UJ			<0.5			
Fluoride (mg/l)			0.42				0.11			
Chloride (mg/l)			0.71				1.56			
Nitrite (mg/l)			<0.05	UJ			<.05	UJ		
Nitrate (mg/l)			<0.1	UJ			1.65	J		
Sulfate (mg/l)			8.35				14.92			
Phosphate (mg/l)			<0.1	UJ			<0.1	UJ		
Elec. Cond. (umho/cm)			105	J			134.1			
pH			8.03				7.59			
TDS (mg/l)			34				113			
Turbidity (mg/l)			<0.2				0.6			
Alkalinity (mg/l)			51	J			67			

9 2 1 2 5 4 0 2 5 2

Site Identification	100H		100F		100F		100F		100F	
Sample Source	river		spring		spring		river		river	
Discharge river/spring (cfs)	8.75E+04		2.30E-03		2.30E-03		8.55E+04		8.55E+04	
Coordinates E (m)	578235		580820		580820		580820		580820	
Coordinates N (m)	152660		148275		148275		148275		148275	
River Mile (nearest 0.1 mi.)	15.3		18.7		18.7		18.7		18.7	
Date	10/21/91		9/27/91		9/27/91		9/27/91		9/27/91	
Time Interval	12:38 - 13:10		10:40 - 12:01		10:40 - 12:01		12:20 - 12:37		12:20 - 12:37	
OSM Sample No.	B015D7	Q	B01599-f	Q	B01599	Q	B015B0-f	Q	B015B0	Q
Quality Control Sample										
Aluminum (ug/l)	160.00	U	32.60	B	112.00	U	17.00	U	36.40	U
Antimony (ug/l)	47.00	U	14.00	U	18.10	U	14.00	U	14.00	U
Barium (ug/l)	28.80	B	24.20	B	25.40	J	24.50	B	26.90	U
Berylium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	3.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Calcium (ug/l)	16300.00		40900.00		42400.00		17000.00		17800.00	
Chromium (ug/l)	6.00	U	2.70	B	7.40	U	2.00	U	6.30	U
Cobalt (ug/l)	8.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Copper (ug/l)	5.00	U	2.00	U	2.00	UJ	2.00	U	2.00	UJ
Iron (ug/l)	183.00		18.90	B	102.00		10.90	B	71.30	U
Magnesium (ug/l)	3830.00	B	9590.00		9710.00		3820.00	B	3870.00	B
Manganese (ug/l)	4.20	B	1.00	U	6.80	U	1.10	B	7.20	U
Nickel (ug/l)	9.00	U	5.00	U	5.00	U	5.00	U	5.00	U
Potassium (ug/l)	820.00	B	1970.00	J	2010.00	J	697.00	J	696.00	J
Silver (ug/l)	4.00	U	5.00	U	5.00	UJ	5.00	U	5.00	UJ
Sodium (ug/l)	1520.00	J	6500.00	J	6690.00	J	1850.00	J	2070.00	J
Vanadium (ug/l)	5.00	U	2.00	U	3.00	U	2.00	U	2.00	U
Zinc (ug/l)	7.00	U	5.00	U	11.20	B	12.00	B	13.60	B
TOC (mg/l)	1.2				0.79				1.6	
COD (mg/l)	<60				<60				<60	
Ammonia (mg/l)	<0.5				<0.5				<0.5	UJ
Fluoride (mg/l)	0.12				0.13				0.39	J
Chloride (mg/l)	0.78				8.19				0.93	J
Nitrite (mg/l)	<.05	UJ			<0.05	UJ			<.05	UJ
Nitrate (mg/l)	0.49	J			2.66	J			<0.1	UJ
Sulfate (mg/l)	8.72				33.82				8.81	J
Phosphate (mg/l)	<0.1	UJ			<0.1	UJ			<0.1	UJ
Elec. Cond. (umho/cm)	89.8				310				97.2	J
pH	8.09				8.11				8.20	
TDS (mg/l)	75				175				88	
Turbidity (mg/l)	1.5				5.3				1.1	
Alkalinity (mg/l)	52				102	J			54.2	J

Site Identification	100F		100F		100F		100F		100F	
Sample Source	spring		spring		river		river		spring	
Discharge river/spring (cfs)	1.20E-03		1.20E-03		8.55E+04		8.55E+04		2.20E-02	
Coordinates E (m)	581230		581230		581230		581230		582621	
Coordinates N (m)	147940		147940		147940		147940		145597	
River Mile (nearest 0.1 mi.)	19.0		19.0		19.0		19.0		20.8	
Date	9/27/91		9/27/91		9/27/91		9/27/91		9/30/91	
Time Interval	8:00 - 9:35		8:00 - 9:35		9:50 - 10:10		9:50 - 10:10		9:10 - 11:15	
OSM Sample No.	B01597-f	Q	B01597	Q	B01598-f	Q	B01598	Q	B015C0-f	Q
Quality Control Sample										
Aluminum (ug/l)	21.90	B	55.10	U	27.20	B	68.00	U	17.80	U
Antimony (ug/l)	14.00	U	18.20	U	14.00	U	18.70	U	14.00	U
Barium (ug/l)	26.40	B	26.80	J	24.40	B	27.50	J	41.60	J
Berylium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Calcium (ug/l)	25600.00		25800.00		17000.00		17800.00		42400.00	
Chromium (ug/l)	2.00	U	2.00	U	2.00	U	2.20	U	3.00	B
Cobalt (ug/l)	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Copper (ug/l)	2.00	U	2.00	UJ	2.00	U	2.00	UJ	2.00	U
Iron (ug/l)	10.70	B	66.40	U	7.00	U	65.90	U	7.00	U
Magnesium (ug/l)	5650.00		5530.00		3770.00	B	3870.00	B	8780.00	
Manganese (ug/l)	1.00	U	4.10	U	1.00	U	7.20	U	1.00	U
Nickel (ug/l)	5.00	U	5.00	U	5.00	U	5.00	U	5.00	U
Potassium (ug/l)	1000.00	J	1030.00	J	665.00	J	689.00	J	2410.00	B
Silver (ug/l)	5.00	U	5.00	UJ	5.00	U	5.00	UJ	5.00	U
Sodium (ug/l)	2370.00	J	2560.00	J	1690.00	J	1970.00	J	9040.00	J
Vanadium (ug/l)	2.00	U	2.00	U	2.00	U	2.00	B	2.00	U
Zinc (ug/l)	6.80	B	12.80	B	5.00	U	6.40	B	8.60	B
TOC (mg/l)			0.79				1.5			
COD (mg/l)			<60				<60			
Ammonia (mg/l)			<0.5				<0.5			
Fluoride (mg/l)			0.39				0.43			
Chloride (mg/l)			1.29				0.71			
Nitrite (mg/l)			<0.05	UJ			<0.05	UJ		
Nitrate (mg/l)			1.80	J			<0.1	UJ		
Sulfate (mg/l)			17.92				8.38			
Phosphate (mg/l)			<0.1	UJ			<0.1	UJ		
Elec. Cond. (umho/cm)			178				120			
pH			7.47				8.16			
TDS (mg/l)			99				56			
Turbidity (mg/l)			<0.2				<0.2			
Alkalinity (mg/l)			66	J			52	J		

Site Identification	100F		100F		100F	
Sample Source	spring		river		river	
Discharge river/spring (cfs)	2.20E-02		8.57E+04		8.57E+04	
Coordinates E (m)	582621		582621		582621	
Coordinates N (m)	145597		145597		145597	
River Mile (nearest 0.1 mi.)	20.8		20.8		20.8	
Date	9/30/91		9/30/91		9/30/91	
Time Interval	9:10 - 11:15		11:50 - 12:20		11:50 - 12:20	
OSM Sample No.	B015C0	Q	B015C1-f	Q	B015C1	Q
Quality Control Sample						
Aluminum (ug/l)	334.00		17.00	U	36.00	B
Antimony (ug/l)	47.00	U	16.10	U	47.00	U
Barium (ug/l)	50.80	B	27.40	J	27.70	B
Berylium (ug/l)	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	3.00	U	1.00	U	3.00	U
Calcium (ug/l)	42300.00		17500.00		18100.00	
Chromium (ug/l)	9.60	B	2.00	U	6.00	U
Cobalt (ug/l)	8.00	U	2.00	U	8.00	U
Copper (ug/l)	5.00	U	2.00	U	5.00	U
Iron (ug/l)	1370.00	J	9.00	U	54.40	J
Magnesium (ug/l)	9040.00		3870.00	B	4040.00	B
Manganese (ug/l)	45.00		1.70	U	8.70	B
Nickel (ug/l)	9.00	U	5.00	U	9.00	U
Potassium (ug/l)	2480.00	B	592.00	B	717.00	B
Silver (ug/l)	4.00	U	5.00	U	4.00	U
Sodium (ug/l)	8970.00	J	1910.00	J	2060.00	J
Vanadium (ug/l)	5.00	U	2.00	U	5.00	U
Zinc (ug/l)	18.00	B	5.00	U	7.00	U
TOC (mg/l)	0.59				1.5	
COD (mg/l)	71				79	
Ammonia (mg/l)	<0.5	UJ			<0.5	UJ
Fluoride (mg/l)	0.13	J			0.12	J
Chloride (mg/l)	9.80	J			1.02	J
Nitrite (mg/l)	<0.05	UJ			<0.05	UJ
Nitrate (mg/l)	4.33	J			<0.1	UJ
Sulfate (mg/l)	40.05	J			9.65	J
Phosphate (mg/l)	<0.1	UJ			<0.1	UJ
Elec. Cond. (umho/cm)	266.4	J			97.0	J
pH	7.80				9.17	
TDS (mg/l)	194				61	
Turbidity (mg/l)	0.35				1.2	
Alkalinity (mg/l)	94.1	J			54.2	J

Site Identification	100F		100F		100F		100F		100F	
Sample Source	spring		spring		river		river		Dup. B015B5	
Discharge river/spring (cfs)	nr		nr		7.11E+04		7.11E+04		1.80E-03	
Coordinates E (m)	582864		582864		582864		582864		582864	
Coordinates N (m)	145130		145130		145130		145130		145130	
River Mile (nearest 0.1 mi.)	21.6		21.6		21.6		21.6		21.6	
Date	9/29/91		9/29/91		9/29/91		9/29/91		9/29/91	
Time Interval	8:35 - 10:17		8:35 - 10:17		11:30 - 12:02		11:30 - 12:02		10:20 - 11:10	
OSM Sample No.	B015B5-f	Q	B015B5	Q	B015B6-f	Q	B015B6	Q	B015B7-f	Q
Quality Control Sample										
Aluminum (ug/l)	17.00	U	121.00	U	19.80	B	85.40	U	17.00	U
Antimony (ug/l)	14.00	U	14.00	U	14.00	U	14.00	U	14.00	U
Barium (ug/l)	42.90	B	45.10	J	26.00	B	28.00	J	43.20	B
Berylium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Calcium (ug/l)	45500.00		46400.00		18100.00		18800.00		45500.00	
Chromium (ug/l)	2.00	U	5.20	U	2.00	U	2.20	U	2.00	U
Cobalt (ug/l)	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Copper (ug/l)	2.00	U	2.00	UJ	2.00	U	2.00	UJ	2.00	U
Iron (ug/l)	7.00	U	231.00		26.10	B	86.20	U	7.00	U
Magnesium (ug/l)	9020.00		9000.00		3980.00	B	4070.00	B	9010.00	
Manganese (ug/l)	1.00	U	6.30	U	1.10	B	7.50	U	1.00	U
Nickel (ug/l)	5.00	U	5.00	U	5.00	U	5.00	U	5.00	U
Potassium (ug/l)	2910.00	J	2970.00	J	795.00	J	728.00	J	2890.00	J
Silver (ug/l)	5.00	U	5.00	UJ	5.00	U	5.00	UJ	5.00	U
Sodium (ug/l)	10100.00	J	10100.00	J	1960.00	J	2220.00	J	10100.00	J
Vanadium (ug/l)	2.30	U	5.00	B	2.00	U	2.90	U	3.10	U
Zinc (ug/l)	5.00	U	11.20	B	6.00	B	10.80	B	5.20	B
TOC (mg/l)			0.94				1.5			
COD (mg/l)			63				71			
Ammonia (mg/l)			<0.5	UJ			<0.5	UJ		
Fluoride (mg/l)			0.15	J			0.42	J		
Chloride (mg/l)			9.71	J			1.02	J		
Nitrite (mg/l)			<.05	UJ			<.05	UJ		
Nitrate (mg/l)			5.50	J			0.51	J		
Sulfate (mg/l)			47.30	J			9.31	J		
Phosphate (mg/l)			<0.1	UJ			<0.1	UJ		
Elec. Cond. (umho/cm)			230.9	J			100.1	J		
pH			7.58				8.24			
TDS (mg/l)			232				63			
Turbidity (mg/l)			1.1				1.8			
Alkalinity (mg/l)			90.25	J			53.2	J		

Site Identification	100F		100F		100F		100F		100F	
Sample Source	spring		spring		river		river		spring	
Discharge river/spring (cfs)	1.80E-03		7.11E+04		7.11E+04		2.30E-03		2.30E-03	
Coordinates E (m)	582864		582864		582864		582962		582962	
Coordinates N (m)	145130		145130		145130		144813		144813	
River Mile (nearest 0.1 mi.)	21.6		21.6		21.6		21.8		21.8	
Date	9/29/91		9/29/91		9/29/91		9/28/91		9/28/91	
Time Interval	10:20 - 11:10		12:11 - 12:42		12:11 - 12:42		10:56 - 12:10		10:56 - 12:10	
OSM Sample No.	B015B7	Q	B015B9-f	Q	B015B9	Q	B015B3-f	Q	B015B3	Q
Quality Control Sample	Dup. B015B5		Dup. B015B5		Dup. B015B6		Dup. B015B6			
Aluminum (ug/l)	859.00		17.00	U	146.00	U	24.90	B	128.00	U
Antimony (ug/l)	19.90	U	14.00	U	14.00	U	14.00	U	14.00	U
Barium (ug/l)	57.60	J	25.60	B	28.20	J	43.20	B	44.60	J
Berylium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Calcium (ug/l)	46900.00		18600.00		18900.00		45600.00		46300.00	
Chromium (ug/l)	4.20	U	2.00	U	4.70	U	2.40	B	6.90	U
Cobalt (ug/l)	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Copper (ug/l)	2.00	UJ	2.00	U	2.00	UJ	2.00	U	2.00	UJ
Iron (ug/l)	1850.00		7.00	U	219.00		24.50	B	184.00	
Magnesium (ug/l)	9280.00		4060.00	B	4100.00	B	8880.00		8810.00	
Manganese (ug/l)	46.40		1.00	U	17.90		1.00	U	7.10	U
Nickel (ug/l)	5.00	U	5.00	U	5.00	U	5.00	U	5.00	U
Potassium (ug/l)	2990.00	J	760.00	J	793.00	J	2970.00	J	2960.00	J
Silver (ug/l)	5.00	UJ	5.00	U	5.00	UJ	5.00	U	5.00	UJ
Sodium (ug/l)	10000.00	J	2050.00	J	2220.00	J	9690.00	J	9700.00	J
Vanadium (ug/l)	7.90	U	2.00	U	2.10	B	4.00	U	4.70	U
Zinc (ug/l)	79.90		5.20	B	11.60	B	5.00	U	7.60	B
TOC (mg/l)	1.1				1.6				0.69	
COD (mg/l)	63				<60				71	
Ammonia (mg/l)	0.60	J			<0.5	UJ			<0.5	UJ
Fluoride (mg/l)	0.16	J			0.11	J			0.15	J
Chloride (mg/l)	9.78	J			0.96	J			9.6	J
Nitrite (mg/l)	<.05	UJ			<.05	UJ			<.05	UJ
Nitrate (mg/l)	5.52	J			0.51	J			4.93	J
Sulfate (mg/l)	47.35	J			9.30	J			49.39	J
Phosphate (mg/l)	<0.1	UJ			<0.1	UJ			<0.1	UJ
Elec. Cond. (umho/cm)	270.8	J			99.5	J			263.1	J
pH	7.48				8.28				7.47	
TDS (mg/l)	225				58				215	
Turbidity (mg/l)	1.5				2.5				0.75	
Alkalinity (mg/l)	89.3	J			53.2	J			92.15	J

Site identification	100F		100F		100F		100F		100F	
Sample Source	river		river		spring		spring		river	
Discharge river/spring (cfs)	7.00E+04		7.00E+04		nn		nn		7.00E+04	
Coordinates E (m)	582962		582962		583132		583132		583132	
Coordinates N (m)	144813		144813		143171		143171		143171	
River Mile (nearest 0.1 mi.)	21.8		21.8		22.1		22.1		22.1	
Date	9/28/91		9/28/91		9/28/91		9/28/91		9/28/91	
Time Interval	12:37 - 12:58		12:37 - 12:58		8:30 - 10:08		8:30 - 10:08		10:10 - 10:35	
OSM Sample No.	B015B4-f	Q	B015B4	Q	B015B1-f	Q	B015B1	Q	B015B2-f	Q
Quality Control Sample										
Aluminum (ug/l)	17.00	U	57.10	U	17.00	U	43.90	B	17.00	U
Antimony (ug/l)	14.00	U	14.00	U	15.00	U	47.00	U	14.00	U
Barium (ug/l)	24.00	B	25.70	J	37.20	J	38.10	B	23.90	B
Berylium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	1.00	U	1.00	U	1.00	U	3.00	U	1.00	U
Calcium (ug/l)	16800.00		17500.00		38600.00		39500.00		17200.00	
Chromium (ug/l)	2.00	U	11.30	U	32.10		6.00	B	2.00	U
Cobalt (ug/l)	2.00	U	2.00	U	2.00	U	8.00	U	2.00	U
Copper (ug/l)	2.00	U	2.00	UJ	2.00	U	5.00	U	2.00	U
Iron (ug/l)	7.00	U	110.00		119.00		31.10	J	7.00	U
Magnesium (ug/l)	3710.00	B	3820.00	B	7290.00		7550.00		3810.00	B
Manganese (ug/l)	1.00	U	7.60	U	2.10	U	2.00	U	1.00	U
Nickel (ug/l)	5.00	U	5.50	B	11.80	B	9.00	U	5.00	U
Potassium (ug/l)	637.00	J	692.00	J	2560.00	B	2630.00	B	632.00	J
Silver (ug/l)	5.00	U	5.00	UJ	5.00	U	4.00	U	5.00	U
Sodium (ug/l)	1700.00	J	1960.00	J	7870.00	J	8170.00	J	1700.00	J
Vanadium (ug/l)	2.00	U	3.00	U	4.20	U	5.00	U	2.00	U
Zinc (ug/l)	5.00	U	9.60	B	5.00	U	10.10	B	5.00	U
TOC (mg/l)			1.5				0.69			
COD (mg/l)			71				71			
Ammonia (mg/l)			<0.5	UJ			<0.5	UJ		
Fluoride (mg/l)			0.40	J			0.15	J		
Chloride (mg/l)			1.00	J			6.99	J		
Nitrite (mg/l)			<.05	UJ			<0.05	UJ		
Nitrate (mg/l)			<0.1	UJ			3.53	J		
Sulfate (mg/l)			9.20	J			38.92	J		
Phosphate (mg/l)			<0.1	UJ			<0.1	UJ		
Elec. Cond. (umho/cm)			105.7	J			228.7	J		
pH			8.44				7.57			
TDS (mg/l)			94				193			
Turbidity (mg/l)			1.0				0.80			
Alkalinity (mg/l)			52.25	J			78.9	J		

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Site Identification	100F		HAN		HAN		HAN		HAN	
Sample Source	river		spring		spring		river		river	
Discharge river/spring (cfs)	7.00E+04		3.30E-02		3.30E-02		9.51E+04		9.51E+04	
Coordinates E (m)	583132		584986		584986		584986		584986	
Coordinates N (m)	144317		140838		140838		140838		140838	
River Mile (nearest 0.1 mi.)	22.1		24.6		24.6		24.6		24.6	
Date	9/28/91		10/2/91		10/2/91		10/2/91		10/2/91	
Time Interval	10:10 - 10:35		13:10 - 15:05		13:10 - 15:05		16:07 - 16:37		16:07 - 16:37	
OSM Sample No.	B015B2	Q	B015C4-f	Q	B015C4	Q	B015C5-f	Q	B015C5	Q
Quality Control Sample										
Aluminum (ug/l)	44.90	U	17.00	B	158.00	B	19.80	U	82.40	B
Antimony (ug/l)	14.00	U	14.00	U	47.00	U	14.00	U	47.00	U
Barium (ug/l)	25.50	J	30.80	J	38.10	B	28.80	J	27.70	B
Berylium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	1.00	U	1.00	U	3.00	U	1.00	U	3.00	U
Calcium (ug/l)	17100.00		34300.00		32800.00		21400.00		19800.00	
Chromium (ug/l)	11.90	U	2.00	U	6.00	U	2.00	U	6.00	U
Cobalt (ug/l)	2.00	U	2.00	U	8.00	U	2.00	U	8.00	U
Copper (ug/l)	2.00	UJ	2.00	U	5.00	U	2.00	U	5.00	U
Iron (ug/l)	93.90	U	17.20	U	224.00	J	16.30	U	148.00	J
Magnesium (ug/l)	3750.00	B	7190.00		7000.00		4660.00	B	4390.00	B
Manganese (ug/l)	9.50	B	1.90	U	7.80	B	2.40	U	10.60	B
Nickel (ug/l)	5.00	U	5.00	U	9.00	U	5.00	U	9.00	U
Potassium (ug/l)	646.00	J	3810.00	B	3890.00	B	1440.00	B	1280.00	B
Silver (ug/l)	5.00	UJ	5.00	U	4.00	U	5.00	U	4.00	U
Sodium (ug/l)	1890.00	J	16000.00	J	15900.00	J	5600.00	J	4340.00	J
Vanadium (ug/l)	2.00	U	7.30	U	5.90	B	3.50	U	5.00	U
Zinc (ug/l)	6.00	B	5.00	U	10.60	B	5.00	U	12.00	B
TOC (mg/l)	1.6				0.50	U			1.9	
COD (mg/l)	71				<60				71	
Ammonia (mg/l)	<0.5	UJ			<0.5	UJ			<0.5	UJ
Fluoride (mg/l)	0.38	J			0.22	J			0.13	J
Chloride (mg/l)	0.90	J			6.09	J			1.62	J
Nitrite (mg/l)	<.05	UJ			<0.05	UJ			<0.05	UJ
Nitrate (mg/l)	<0.1	UJ			1.58	J			0.56	J
Sulfate (mg/l)	8.84	J			26.47	J			11.62	J
Phosphate (mg/l)	<0.1	UJ			<0.1	UJ			<0.1	UJ
Elec. Cond. (umho/cm)	96.9	J			243.1	J			125.4	J
pH	7.79				7.93				8.25	
TDS (mg/l)	93				206				109	
Turbidity (mg/l)	0.38				2.1				3.4	
Alkalinity (mg/l)	49.4	J			110.2	J			62.7	J

Site Identification	HAN		HAN		HAN		HAN		HAN	
Sample Source	spring		spring		river		river		spring	
Discharge river/spring (cfs)	3.30E-02		3.30E-02		9.51E+04		9.51E+04		4.70E-03	
Coordinates E (m)	585059		585059		585059		585059		585729	
Coordinates N (m)	140777		140777		140777		140777		140070	
River Mile (nearest 0.1 mi.)	24.7		24.7		24.7		24.7		25.2	
Date	10/2/91		10/2/91		10/2/91		10/2/91		10/2/91	
Time Interval	15:10 - 15:20		15:10 - 15:20		15:35 - 16:00		15:35 - 16:00		9:25 - 11:37	
OSM Sample No.	B015C6-f	Q	B015C6	Q	B015C7-f	Q	B015C7	Q	B015C2-f	Q
Quality Control Sample	Dup. B015C4		Dup. B015C4		Dup. B015C5		Dup. B015C5			
Aluminum (ug/l)	17.00	U	111.00	B	35.70	U	137.00	B	17.00	U
Antimony (ug/l)	14.00	U	47.00	U	16.00	U	47.00	U	14.00	U
Barium (ug/l)	30.70	J	38.10	B	29.10	J	27.70	B	30.70	J
Beryllium (ug/l)	1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	1.00	U	3.00	U	1.00	U	3.00	U	1.00	U
Calcium (ug/l)	33600.00		32900.00		20400.00		18000.00		19700.00	
Chromium (ug/l)	2.00	U	6.00	U	2.00	U	6.00	U	2.00	U
Cobalt (ug/l)	2.00	U	8.00	U	2.00	U	8.00	U	2.00	U
Copper (ug/l)	2.00	U	5.00	U	2.00	U	5.00	U	2.00	U
Iron (ug/l)	7.00	U	157.00	J	75.90	B	192.00	J	7.00	U
Magnesium (ug/l)	7070.00		7040.00		4510.00	B	4020.00	B	4750.00	B
Manganese (ug/l)	1.90	U	5.40	B	2.10	U	12.10	B	1.00	U
Nickel (ug/l)	5.00	U	9.00	U	5.00	U	9.00	U	5.00	U
Potassium (ug/l)	3740.00	B	3810.00	B	1270.00	B	1070.00	B	940.00	B
Silver (ug/l)	5.00	U	4.00	U	5.00	U	4.00	U	5.00	U
Sodium (ug/l)	15700.00	J	15700.00	J	4800.00	J	3260.00	J	2700.00	J
Vanadium (ug/l)	6.40	U	5.00	U	2.30	U	5.00	U	2.00	U
Zinc (ug/l)	5.00	U	10.90	B	6.10	B	10.60	B	5.00	U
TOC (mg/l)			0.64				2.0			
COD (mg/l)			95				71			
Ammonia (mg/l)			<0.5	UJ			<0.5	UJ		
Fluoride (mg/l)			0.22	J			0.12	J		
Chloride (mg/l)			6.08	J			1.31	J		
Nitrite (mg/l)			<0.05	UJ			<0.05	UJ		
Nitrate (mg/l)			1.57	J			0.50	J		
Sulfate (mg/l)			26.54	J			10.44	J		
Phosphate (mg/l)			<0.1	UJ			<0.1	UJ		
Elec. Cond. (umho/cm)			243.1	J			106.7	J		
pH			7.91				8.42			
TDS (mg/l)			212				94			
Turbidity (mg/l)			2.5				2.9			
Alkalinity (mg/l)			110.2	J			58.9	J		

Site Identification	HAN		HAN		HAN	
Sample Source	spring		river		river	
Discharge river/spring (cfs)	4.70E-03		9.51E+04		9.51E+04	
Coordinates E (m)	585729		585729		585729	
Coordinates N (m)	140070		140070		140070	
River Mile (nearest 0.1 mi.)	25.2		25.2		25.2	
Date	10/2/91		10/2/91		10/2/91	
Time Interval	9:25 - 11:37		12:09 - 12:31		12:09 - 12:31	
OSM Sample No.	B015C2	Q	B015C3-f	Q	B015C3	Q
Quality Control Sample						
Aluminum (ug/l)	92.30	B	17.00	U	42.90	B
Antimony (ug/l)	47.00	U	14.40	U	47.00	U
Barium (ug/l)	27.70	B	26.50	J	27.70	B
Berylium (ug/l)	1.00	U	1.00	U	1.00	U
Cadmium (ug/l)	3.00	U	1.00	U	3.00	U
Calcium (ug/l)	19200.00		16800.00		17000.00	
Chromium (ug/l)	6.00	U	2.00	U	6.00	U
Cobalt (ug/l)	8.00	U	2.00	U	8.00	U
Copper (ug/l)	5.00	U	2.00	U	5.00	U
Iron (ug/l)	96.10	J	7.00	U	84.40	J
Magnesium (ug/l)	4670.00	B	3710.00	B	3820.00	B
Manganese (ug/l)	4.50	B	1.50	U	6.50	B
Nickel (ug/l)	9.00	U	5.00	U	9.00	U
Potassium (ug/l)	1070.00	B	587.00	B	726.00	B
Silver (ug/l)	4.00	U	5.00	U	4.00	U
Sodium (ug/l)	2670.00	J	1640.00	J	1820.00	J
Vanadium (ug/l)	5.00	U	2.00	U	5.00	U
Zinc (ug/l)	7.00	U	5.00	U	11.20	B
TOC (mg/l)	0.94				1.6	
COD (mg/l)	79				<60	
Ammonia (mg/l)	<0.5	UJ			<0.5	UJ
Fluoride (mg/l)	0.12	J			0.12	J
Chloride (mg/l)	1.17	J			0.83	J
Nitrite (mg/l)	<0.05	UJ			<0.05	UJ
Nitrate (mg/l)	0.68	J			<0.1	UJ
Sulfate (mg/l)	10.53	J			8.76	J
Phosphate (mg/l)	<0.1	UJ			<0.1	UJ
Elec. Cond. (umho/cm)	119.8	J			101.8	J
pH	7.36				8.16	
TDS (mg/l)	349				68	
Turbidity (mg/l)	0.76				1.2	
Alkalinity (mg/l)	60.8	J			52.3	J

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APPENDIX D

RADIOLOGICAL ANALYSES OF WATER SAMPLES

Validation of the chemical portion of the analysis has been completed with no significant impact on data quality noted. Validation of the radiological data contained in this report has yet to be completed. Additional information was needed from the analytical laboratories in order to complete the validation process in accordance with approved Westinghouse Hanford procedures.

Receipt of the needed information is expected February 29, 1992. The validation process will take an additional 2 weeks to complete. No significant changes or impacts on data quality are anticipated at this time. Once the validation is completed the analytical data tables will be revised as necessary.

EXPLANATION OF TERMS

Site Identification: This identifier denotes the specific reactor area or general region of the sampling location.

Sample Type: Identifies the source of the sample, either spring or river

Discharge river/spring (ft^3/s): Identifies the average discharge of the Columbia River for the day of sampling or the estimated discharge of the individual spring at the time of sampling. Discharges are in ft^3/s.

Coordinates E (m)
Coordinates N (m): Identifies the location of the sample location according to the NAD 1983 Washington State South Zone Coordinates in Meters .

River Mile (nearest 0.1 mi.): Identifies the approximate Hanford River Mile. Hanford River Mile 0.0 is at the Vernita Bridge. Measurements are scaled from the 1:2000 maps of the Hanford Site.

Date: Day on which the specific sample was collected.

Time Interval: The sampling interval, starting with the initiation of presampling measurements for the springs. For river samples, the interval denotes the actual time during which the sample was collected.

OSM Sample No.: The sample tracking number assigned to a specific set of samples. Each spring/sediment sample had a single number; the adjacent river sample was assigned a separate number. All numbers were supplied by Westinghouse Hanford OSM.

2 σ Calculated value of plus or minus two standard deviations for the radiological analysis.

pCi/L Pico Curie per Liter.

N/A Data not available from laboratory.

Site Identification	100B		100B		100B		100K		100K		100K	
Sample Type	spring		river		spring		spring		river		spring	
Discharge river/spring (cfs)	5.90E-04		9.35E+04		3.30E-03		2.90E-04		9.30E+04		1.80E-02	
Coordinates E (m)	564540		564940		564675		567585		567585		569680	
Coordinates N (m)	145275		145350		145275		146210		146210		148070	
River Mile (nearest 0.1 mi.)	3.7		3.7		3.8		5.6		5.6		7.4	
Date	9/18/91		9/18/91		9/17/91		9/25/91		9/25/91		10/16/91	
Time Interval	9:45 - 11:45		10:48 - 11:45		13:25 - 16:19		7:25 - 9:05		9:15 - 9:50		12:30 - 13:30	
OSM Sample No.	B01579		B01580		B01578		B01589		B01590		B015D2	
Quality Control Sample												
Concentration in pCi/L		2σ		2σ		2σ		2σ		2σ		2σ
Gross Alpha	0	1	1	1	2	2	0	2	0	1	1	1
Gross Beta	5	1	7	2	15	2	11	2	1	2	18	1
H(3)	13000	700	300	200	20600	900	1400	300	<300		400	100
Sr(90)	<0.4		0.6	0.4	0.96	0.29	<1		0.4	0.2	8.8	0.6
Tc(99)	N/A		N/A		N/A		N/A		N/A		5.2	1.6
Total Uranium	272	26	0.4	0.04	1.6	0.2	1	0.1	0.39	0.04	0.24	0.02
Gamma Scan												
K(40)	<134.1		<288.3		<146.9		<138.3		<257.7		<247.6	
Cr(51)	<312.0		<346.9		<259.8		<381.7		<387.9		<498.4	
Co(60)	<18.63		<17.68		<16.24		<16.45		<15.74		<15.25	
Zn(65)	<23.88		<30.35		<25.76		<28.73		<36.27		<38.45	
Cs(134)	<12.61		<16.24		<10.97		<12.35		<15.93		<15.75	
Cs(137)	<11.70		<15.25		<10.16		<10.88		<12.91		<14.51	
Ra(226)	<23.39		<30.46		<35.54		<26.12		<23.49		<28.44	
Th(228)	<20.42		<22.51		<17.58		<19.67		<21.08		<22.27	
Th(232)	<47.24		<61.35		<48.71		<44.66		<65.51		<94.88	
Sb (125)	N/A		N/A		N/A		N/A		N/A		N/A	

Site Identification	100K		100K		100K		100N		100N		100N	
Sample Type	river		spring		river		spring		river		spring	
Discharge river/spring (cfs)	7.62E+04		2.20E-02		9.08E+04		2.90E-01		8.16E+04		5.90E-01	
Coordinates E (m)	569680		570415		570415		571300		571300		571465	
Coordinates N (m)	148070		148780		148780		149920		149920		150150	
River Mile (nearest 0.1 mi.)	7.4		8.1		8.1		9.0		9.0		9.1	
Date	10/16/91		10/18/91		10/18/91		10/15/91		10/15/91		10/15/91	
Time Interval	12:40 - 13:26		14:10 - 16:05		15:25 - 15:55		11:00 - 12:30		11:10 - 12:00		14:02 - 15:07	
OSM Sample No.	B015D3		B015F2		B015F3		B015C8		B015C9		B015D0	
Quality Control Sample												
Concentration in pCi/L		2σ		2σ		2σ		2σ		2σ		2σ
Gross Alpha	0	1	1	1	2	1	0	3	0	1	1	1
Gross Beta	2	1	4	1	1	1	6830	22	6	1	5	1
H(3)	<200		8900	500	<200		15900	800	300	100	3400	200
Sr(90)	0.7	0.2	<0.5		<0.8		3210	70	8.1	1.2	395	12
Tc(99)	2	1	<2		<3		2.5	2.2	<2.4		3.6	1.3
Total Uranium	0.29	0.03	1.1	0.1	0.49	0.04	0.32	0.03	0.32	0.03	0.24	0.02
Gamma Scan												
K(40)	<128.8		<307.0		<101.0		<142.00		<249.8		<129.1	
Cr(51)	<435.9		<477.1		<315.7		<415.8		<495.5		<467.3	
Co(60)	<17.94		<14.10		<15.51		<17.98		44.73 +/- 17.82		<23.32	
Zn(65)	<30.79		<37.28		<19.99		<26.01		<41.25		<21.85	
Cs(134)	<11.55		<14.33		<9.093		<12.56		<15.18		<16.01	
Cs(137)	<11.54		<14.44		<8.608		<11.79		<13.82		<12.25	
Ra(226)	<29.61		<25.13		<17.10		<25.16		<28.24		<39.49	
Th(228)	<20.50		<20.80		<14.88		<20.32		<20.64		<20.79	
Th(232)	<54.78		<58.27		<40.49		<47.72		<61.49		<66.83	
Sb (125)	N/A		N/A		N/A		N/A		N/A		31.01	24.86

Site Identification	100N		100N		100N		100N		100N		100N	
Sample Type	river		spring		river		spring		river		spring	
Discharge river/spring (cfs)	8.16E+04		2.20E-02		9.08E+04		4.50E-03		9.08E+04		2.20E-02	
Coordinates E (m)	571465		571480		571480		571500		571500		571680	
Coordinates N (m)	150150		150170		150170		150185		150185		150465	
River Mile (nearest 0.1 mi.)	9.1		9.2		9.2		9.2		9.2		9.4	
Date	10/15/91		10/18/91		10/18/91		10/18/91		10/18/91		10/17/91	
Time Interval	14:15 - 14:42		12:12 - 13:28		12:37 - 12:50		10:30 - 11:30		10:41 - 11:09		10:05 - 11:45	
OSM Sample No.	B015D1		B015F0		B015F1		B015D8		B015D9		B015D4	
Quality Control Sample												
Concentration in pCi/L		2σ		2σ		2σ		2σ		2σ		2σ
Gross Alpha	0	1	1	1	0	1	1	1	0	1	1	1
Gross Beta	2	1	7	1	1	1	6	2	2	1	5	1
H(3)	200	100	24300	1200	<200		23900	1200	800	100	20300	1000
Sr(90)	3	1	<0.3		<0.4		<0.2		0.4	0.2	<1	
Tc(99)	3.9	1.6	3.6	1.6	<3		6.2	3	<5		5	3
Total Uranium	0.29	0.03	0.41	0.04	0.3	0.03	0.36	0.03	0.28	0.03	0.274	0.024
Gamma Scan												
K(40)	<232.4		<219.8		<121.2		<252.9		111.7	102.1	<278.5	
Cr(51)	<546.3		<434.1		<490.6		<502.1		<369.4		<476.1	
Co(60)	<19.47		<13.19		<16.21		<20.49		<15.19		<14.58	
Zn(65)	<32.69		<26.37		<33.98		<33.01		<21.67		<31.09	
Cs(134)	<14.86		<12.23		<13.84		<16.42		<10.22		<16.38	
Cs(137)	<15.06		<12.26		<11.68		<14.95		<9.389		<12.67	
Ra(226)	<32.49		<21.62		<24.47		<29.22		<19.74		<25.04	
Th(228)	<22.12		<17.58		<20.43		<21.31		<16.90		<21.34	
Th(232)	<63.31		<49.67		<51.37		<63.85		<35.89		<58.11	
Sb (125)	N/A		N/A		N/A		N/A		N/A		N/A	

Site Identification	100N		100D		100D		100H		100H		100H	
Sample Type	river		river		spring		spring		river		spring	
Discharge river/spring (cfs)	1.16E+05		9.48E+04		2.90E-04		1.20E-03		8.24E+04		nr	
Coordinates E (m)	571680		573597		571597		577080		577080		577255	
Coordinates N (m)	150465		152470		152470		153770		153770		153660	
River Mile (nearest 0.1 mi.)	9.4		11.0		11.0		14.3		14.3		14.4	
Date	10/17/91		9/26/91		9/26/91		9/20/91		9/20/91		9/20/91	
Time Interval	10:30 - 11:22		10:55 - 11:15		9:25 - 10:55		9:15 - 11:17		10:30 - 11:17		11:48 - 13:40	
OSM Sample No.	B015D5		B01594		B01593		B01581		B01582		B01587	
Quality Control Sample												
Concentration in pCi/L		2σ		2σ		2σ		2σ		2σ		2σ
Gross Alpha	0	1	0	1	0	1	1	1	0	1	0	2
Gross Beta	2	1	3	1	9	1	3	1	1	1	0	2
H(3)	<200		<200		3100	400	2900	400	300	200	2900	400
Sr(90)	90	80	<1		1.8	1	0.4	0.2	<0.1		0.6	0.2
Tc(99)	1.7	1.2	<1		4.9	1.1	<6		<3		<1	
Total Uranium	0.283	0.025	0.33	0.03	1	0.1	1	0.1	0.37	0.04	1.0	0.1
Gamma Scan												
K(40)	<174.7		<119		<146.6		<128.9		<235.6		<152.1	
Cr(51)	<472.4		<614.2		<411.7		<275.9		<608.0		<581.9	
Co(60)	<18.48		<16.42		<19.31		<8.432		<13.39		<21.89	
Zn(65)	<22.76		<23.62		<30.38		<17.01		<31.97		<37.08	
Cs(134)	<15.92		<14.11		<14.20		<7.97		<13.45		<12.29	
Cs(137)	<11.90		<12.91		<13.84		<7.522		<13.84		<13.18	
Ra(226)	22.58	21.93	<30.25		<27.48		<14.03		<23.70		<27.17	
Th(228)	<20.20		<20.06		<18.93		<11.63		<21.00		<20.83	20.17
Th(232)	<50.80		<58.95		<53.53		<32.62		56.31		<48.60	
Sb (125)	N/A		N/A		N/A		N/A		N/A		N/A	

9 2 1 2 4 5 1 0 2 5 9

Site Identification	100H		100H		100H		100H		100H		100H	
Sample Type	river		spring		river		spring		river		spring	
Discharge river/spring (cfs)	8.24E+04		1.80E-03		9.09E+04		3.00E-04		9.48E+04		4.70E-03	
Coordinates E (m)	577255		577330		577330		577885		577885		578235	
Coordinates N (m)	153660		153615		153615		153160		153160		152660	
River Mile (nearest 0.1 mi.)	14.4		14.5		14.5		14.9		14.9		15.3	
Date	9/20/91		9/25/91		9/25/91		9/26/91		9/26/91		10/21/91	
Time Interval	12:55 - 13:20		11:22 - 13:00		13:00 - 13:25		12:05 - 13:35		14:00 - 14:30		11:35 - 13:10	
OSM Sample No.	B01588		B01591		B01592		B01595		B01596		B015D6	
Quality Control Sample												
Concentration in pCi/L		2σ		2σ		2σ		2σ		2σ		2σ
Gross Alpha	1	1	1	2	0	1	0	1	0	1	1	1
Gross Beta	0	1	3	1	2	1	3	1	2	1	35	3
H(3)	400	200	3800	500	<300		1100	300	<200		400	100
Sr(90)	0.4	0.3	3	2	<1		<1		<2		12.7	1.4
Tc(99)	2	1	<3		2	1	<2		3.4	1.5	12	2
Total Uranium	0.36	0.03	278	26	0.53	0.05	0.8	0.1	0.34	0.03	0.66	0.06
Gamma Scan												
K(40)	<239.9		<67.62		<226.6		268.3		<138.6		<197.8	
Cr(51)	<660.1		<210.9		<339.7		<640.7		<635.9		<385.8	
Co(60)	<15.11		<10.19		<15.14		<16.62		<19.59		<12.57	
Zn(65)	<35.77		<15.42		<30.30		<30.20		<31.18		<28.26	
Cs(134)	<15.13		<6.664		<14.25		<17.40		<12.81		<12.28	
Cs(137)	<14.00		<6.289		<13.61		<15.47		<11.76		<10.84	
Ra(226)	<26.27		<12.79		25.82	22.29	<26.50		<25.02		<19.15	
Th(228)	<21.28		12.46	10.87	<20.35		<34.73		<18.84		<16.06	
Th(232)	<60.60		<27.64		<57.14		<56.44		<53.84		<46.72	
Sb (125)	N/A		N/A		N/A		N/A		N/A		N/A	

Site Identification	100H		100F		100F		100F		100F		100F	
Sample Type	river		spring		river		spring		river		spring	
Discharge river/spring (cfs)	8.75E+04		2.30E-03		8.55E+04		1.20E-03		8.55E+04		2.20E-02	
Coordinates E (m)	578235		580820		580820		581230		581230		582621	
Coordinates N (m)	152660		148275		148275		147940		147940		145597	
River Mile (nearest 0.1 mi.)	15.3		18.7		18.7		19.0		19.0		20.8	
Date	10/21/91		9/27/91		9/27/91		9/27/91		9/27/91		9/30/91	
Time Interval	12:38 - 13:10		10:40 - 12:01		12:20 - 12:37		8:00 - 9:35		9:50 - 10:10		9:10 - 11:15	
OSM Sample No.	B015D7		B01599		B015B0		B01597		B01598		B015C0	
Quality Control Sample												
Concentration in pCi/L		2σ		2σ		2σ		2σ		2σ		2σ
Gross Alpha	0	1	1	1	1	1	0	1	0	1	N/A	
Gross Beta	2	1	3	2	1	1	6	1	1	1	N/A	
H(3)	<200		<400		<200		<200		<200		N/A	
Sr(90)	0.7	0.2	46	25	<1		2.5	0.4	<2		N/A	
Tc(99)	2.6	1.4	N/A		N/A		N/A		N/A		N/A	
Total Uranium	0.3	0.03	2.6	0.2	0.37	0.04	0.31	0.03	0.32	0.03	N/A	
Gamma Scan												
K(40)	<157.1		<200.1		<147.5		<240.9		<131.3		N/A	
Cr(51)	<152.1		<513.9		<646.7		<723.2		<628.4		N/A	
Co(60)	<10.89		<13.74		<19.09		<15.18		<14.61		N/A	
Zn(65)	<20.03		<28.92		<24.23		<30.30		<28.50		N/A	
Cs(134)	<8.774		<12.01		<11.92		<14.95		<13.46		N/A	
Cs(137)	<8.863		<11.74		<10.85		<15.35		<10.92		N/A	
Ra(226)	<17.17		<20.45		<22.73		<27.26		<21.32		N/A	
Th(228)	<13.48		<18.52		<24.58		<21.22		<18.22		N/A	
Th(232)	<38.77		<49.38		<51.74		<63.90		<45.93		N/A	
Sb (125)	N/A		N/A		N/A		N/A		N/A		N/A	

Site Identification	100F		100F		100F		100F		100F		100F	
Sample Type	river		spring		river		spring		river		spring	
Discharge river/spring (cfs)	8.57E+04		nr		7.11E+04		1.80E-03		7.11E+04		2.30E-03	
Coordinates E (m)	582621		582864		582864		582864		582864		582962	
Coordinates N (m)	145597		145130		145130		145130		145130		144813	
River Mile (nearest 0.1 mi.)	20.8		21.6		21.6		21.6		21.6		21.8	
Date	9/30/91		9/29/91		9/29/91		9/29/91		9/29/91		9/28/91	
Time Interval	11:50 - 12:20		8:35 - 10:17		11:30 - 12:02		10:20 - 11:10		12:11 - 12:42		10:56 - 12:10	
OSM Sample No.	B015C1		B015B5		B015B6		B015B7		B015B9		B015B3	
Quality Control Sample							Dup. B015B5		Dup. B015B6			
Concentration in pCi/L		2σ		2σ		2σ		2σ		2σ		2σ
Gross Alpha	N/A		1	1	0	1	2	2	N/A		1	2
Gross Beta	N/A		5	1	1	1	5	1	N/A		2	2
H(3)	N/A		<200		<300		<200		N/A		<300	
Sr(90)	N/A		<1		<1		<1		N/A		40	30
Tc(99)	N/A		N/A		N/A		N/A		N/A		N/A	
Total Uranium	N/A		2.2	0.2	0.46	0.04	2.4	0.2	N/A		1.9	0.2
Gamma Scan												
K(40)	N/A		<196.3		<115.6		<238.9		N/A		<269.1	
Cr(51)	N/A		<519.7		<614.8		<682.1		N/A		<731.2	
Co(60)	N/A		<12.64		<19.49		<14.65		N/A		<17.16	
Zn(65)	N/A		<26.41		<28.05		<32.64		N/A		<31.60	
Cs(134)	N/A		<13.68		<12.13		<16.57		N/A		<17.29	
Cs(137)	N/A		<12.47		<11.39		<13.97		N/A		<14.77	
Ra(226)	N/A		<20.37		<23.72		<26.01		N/A		<25.78	
Th(228)	N/A		<16.93		<20.63		<21.33		N/A		<22.79	
Th(232)	N/A		<48.65		<51.25		<61.38		N/A		<63.15	
Sb (125)	N/A		N/A		N/A		N/A		N/A		N/A	

Site Identification	100F		100F		100F		HAN		HAN		HAN	
Sample Type	river		spring		river		river		spring		spring	
Discharge river/spring (cfs)	7.00E+04		nr		7.00E+04		9.51E+04		3.30E-02		3.30E-02	
Coordinates E (m)	582962		583132		583132		584986		584986		585059	
Coordinates N (m)	144813		144317		144317		140838		140838		140777	
River Mile (nearest 0.1 mi.)	21.8		22.1		22.1		24.6		24.6		24.7	
Date	9/28/91		9/28/91		9/28/91		10/2/91		10/2/91		10/2/91	
Time Interval	12:37 - 12:58		8:30 - 10:08		10:10 - 10:35		16:07 - 16:37		13:10 - 15:05		15:10 - 15:20	
OSM Sample No.	B015B4		B015B1		B015B2		B015C5		B015C4		B015C6	
Quality Control Sample											Dup. B015C4	
Concentration in pCi/L		2σ		2σ		2σ		2σ		2σ		2σ
Gross Alpha	2	1	2	2	1	1	0	1	0	1	1	1
Gross Beta	1	1	3	1	1	1	4	1	4	2	6	2
H(3)	<200		<200		<200		<270		<240		<190	
Sr(90)	<1		<1		<40		<1		<0.3		<.04	
Tc(99)	N/A		N/A		N/A		N/A		N/A		N/A	
Total Uranium	0.31	0.03	1.2	0.1	0.37	0.04	0.49	0.05	1.69	0.16	1.61	0.15
Gamma Scan												
K(40)	<118.7		<249.3		<140.5		<91.41		<215.5		<268.2	
Cr(51)	<558.4		<728.5		<591.5		<532.1		<511.4		<543.5	
Co(60)	<17.85		<17.08		<16.99		<17.94		<15.60		<16.66	
Zn(65)	<23.37		<35.66		<25.78		<26.99		<32.51		<38.87	
Cs(134)	<12.48		<16.23		<12.27		<13.69		<15.65		<15.29	
Cs(137)	<10.71		<13.78		<12.51		<14.13		<14.03		<14.43	
Ra(226)	<20.59		<24.70		<25.83		35.71	25.59	<25.77		<25.25	
Th(228)	<19.61		<21.98		<21.14		<20.34		<20.47		<22.12	
Th(232)	<44.70		<60.57		<47.81		<44.19		<54.82		<59.99	
Sb (125)	N/A		N/A		N/A		N/A		N/A		N/A	

Site Identification	HAN		HAN		HAN	
Sample Type	river		spring		river	
Discharge river/spring (cfs)	9.51E+04		4.70E-03		9.51E+04	
Coordinates E (m)	585059		585729		585729	
Coordinates N (m)	140777		140070		140070	
River Mile (nearest 0.1 mi.)	24.7		25.2		25.2	
Date	10/2/91		10/2/91		10/2/91	
Time Interval	15:35 - 16:00		9:25 - 11:37		12:09 - 12:31	
OSM Sample No.	B015C7		B015C2		B015C3	
Quality Control Sample	Dup. B015C5					
Concentration in pCi/L		2σ		2σ		2σ
Gross Alpha	1	1	0	1	0	1
Gross Beta	2	1	3	1	2	1
H(3)	<170		<260		<170	
Sr(90)	0.4	0.2	<.4		<0.8	
Tc(99)	N/A		N/A		N/A	
Total Uranium	0.69	0.07	0.26	0.02	0.3	0.03
Gamma Scan						
K(40)	<212.3		<207.2		<111.7	
Cr(51)	<468.1		<458.6		<463.5	
Co(60)	<12.69		<14.00		<16.95	
Zn(65)	<28.65		<28.30		<24.72	
Cs(134)	<11.91		<14.03		<11.52	
Cs(137)	<13.02		<13.26		<10.00	
Ra(226)	<23.23		<25.16		<24.39	
Th(228)	<18.20		<19.80		<19.24	
Th(232)	<49.00		<51.49		<51.09	
Sb (125)	N/A		N/A		N/A	

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APPENDIX E

CHEMICAL AND RADIOLOGICAL ANALYSES OF SEDIMENTS.

EXPLANATION OF TERMS

Site Identification:	This identifier denotes the specific reactor area or general region of the sampling location.
Sample Type:	All samples are sediments
Coordinates E (m) Coordinates N (m):	Identifies the location of the sample location according to the NAD 1983 Washington State South Zone Coordinates in Meters .
River Mile (nearest 0.1 mi):	Identifies the approximate Hanford River Mile. Hanford River Mile 0.0 is at the Vernita Bridge. Measurements are scaled from the 1:2000 maps of the Hanford Site.
Date:	Day on which the specific sample was collected.
OSM Sample No.:	The sample tracking number assigned to a specific set of samples. Each spring/sediment sample had a single number. All numbers were supplied by Westinghouse Hanford OSM.
Q (Qualifier):	Qualifier codes were supplied through the data validation process: U - none detected; numerical value is sample quantitation limit J - estimated value (less than quatitation limit) B - analyte found in associated blank as well as in sample UJ - not detected; quantitation limit is estimated <blank> - positive
2σ	Calculated value of plus or minus two standard deviations.
mg/kg	milligram per kilogram
pCi/g	Pico Curie per gram
N/A	Data not available from analytical laboratory. Data qualifiers for radiological analyses are statistical evaluations of counting errors and are provided as plus or minus to standard deviations (sigma).

Site Identification	100B		100B		100K		100K		100K	
Coordinates E (m)	564540		564675		567585		569680		570415	
Coordinates N (m)	145275		145275		146210		148070		148780	
River Mile (nearest 0.1 mi	3.7		3.8		5.6		7.4		8.1	
Date	9/18/91		9/17/91		9/25/91		10/16/91		10/18/91	
OSM Sample No.	B01579	Q	B01578	Q	B01589	Q	B015D2	Q	B015F2	Q
Quality Control Sample										
Aluminum (mg/kg)	6180		6060		6030		5390		5970	
Antimony (mg/kg)	22.2	UJ	14	UJ	11.6	UJ	11.9	UJ	9.2	UJ
Barium (mg/kg)	61.7	B	52.1	B	102	J	59.5		79.5	
Beryllium (mg/kg)	0.47	U	0.28	U	0.36	B	0.25	U	0.2	U
Cadmium (mg/kg)	1.4	U	0.85	U	0.74	U	0.76	U	0.59	U
Calcium (mg/kg)	3780		2550		3500	J	3090		2980	
Chromium (mg/kg)	52.1	J	51.7	J	29.3	J	39.6		34.9	
Cobalt (mg/kg)	6.8	J	5.4	J	7.1	B	6.5	B	6.1	B
Copper (mg/kg)	18.2		15.8		19.1		17.5	J	17.9	J
Iron (mg/kg)	11700		11500		21500	J	14400		14200	
Magnesium (mg/kg)	3530		3420		2940		3310		3410	
Manganese (mg/kg)	154		135		335	J	238	J	493	J
Nickel (mg/kg)	12.1	B	12.5		13.6		11		13	
Potassium (mg/kg)	1180	B	1050	B	707	B	670	B	697	B
Silver (mg/kg)	1.9	U	1.1	U	0.98	U	1	U	0.78	U
Sodium (mg/kg)	188	J	117	J	242	J	152	J	131	J
Vanadium (mg/kg)	26.7		23.2		37.2		29.6		32.8	
Zinc (mg/kg)	208		79.6		280	J	173	J	80.3	J
		2σ		2σ		2σ		2σ		2σ
Gross Alpha	4	4	11	4	8	3	9	5	5	5
Gross Beta	15	3	20	3	12	2	22	3	23	3
Sr(90)	0.3	0.1	0.4	0.2	0.2	0.1	0.6	0.3	<0.6	
Tc(99)	N/A		N/A		N/A		N/A		N/A	
Gamma Scan										
K(40)	13.91	0.66	13.03	0.53	11.44	0.43	14.18	0.5	14.58	0.51
Cr(51)	<1.446		<1.129		<86.09		<0.6844		<0.7409	
Mn(54)	N/A		N/A		N/A		N/A		N/A	
Co(60)	<0.03975		<0.02597		<0.02252		0.04224	0.021	0.03582	0.0272
Zn(65)	<0.0932		<0.06701		<0.05262		<0.06544		<0.07149	
Sb(124)	N/A		N/A		NA/		N/A		N/A	
Cs(134)	<0.0399		<0.02682		<0.02426		<0.02949		<0.03418	
Cs(137)	0.1456	0.0291	0.03309	0.0141	0.1476	0.0148	0.2138	0.0285	0.187	0.0283
Ce (141)	N/A		N/A		N/A		N/A		N/A	
Eu(152)	N/A		N/A		N/A		0.1255	0.0376	0.1004	0.0476
Eu(154)	N/A		N/A		N/A		N/A		N/A	
Eu(155)	N/A		N/A		N/A		0.04961	0.0481	0.07686	0.0474
Ra(226)	0.7755	0.0673	0.4461	0.0411	0.7274	0.0461	0.8171	0.0457	1.019	0.058
Th(228)	1.024	0.04	0.7763	0.0313	0.7912	0.0274	0.9329	0.0287	1.516	0.035
Th(232)	0.9552	0.143	0.6726	0.0882	0.776	0.0913	1.051	0.099	1.419	0.113
U(235)	N/A		N/A		N/A		N/A		N/A	

Radionuclides are reported as pCi/g

Site Identification	100N		100N		100N		100N		100N	
Coordinates E (m)	571300		571465		571480		571500		571680	
Coordinates N (m)	149920		150150		150170		150185		150465	
River Mile (nearest 0.1 mi	9.0		9.1		9.2		9.2		9.4	
Date	10/15/91		10/15/91		10/18/91		10/18/91		10/17/91	
OSM Sample No.	BO15C8	Q	B015D0	Q	B015F0	Q	B015D8	Q	B015D4	Q
Quality Control Sample										
Aluminum (mg/kg)	4800		5870		6910		4850		5590	
Antimony (mg/kg)	6.3	J	2.9	UJ	10.9	UJ	10.9	UJ	10	UJ
Barium (mg/kg)	54.2		57.1		111		81.7		61.3	
Berylium (mg/kg)	0.24	B	0.21	U	0.23	U	0.23	U	0.21	U
Cadmium (mg/kg)	0.22	U	0.5	B	0.7	U	0.9	B	0.64	U
Calcium (mg/kg)	3160		2710		3300		3680		2910	
Chromium (mg/kg)	10.3	J	13.4	J	14.5		9.1		10.9	
Cobalt (mg/kg)	7.3	B	6.8	B	8.2	B	8.9	B	7.3	B
Copper (mg/kg)	16.7	J	13.1	J	18	J	17.4	J	17.3	J
Iron (mg/kg)	15400		14500		18300		16400		15200	
Magnesium (mg/kg)	3270		3110		3960		3130		2870	
Manganese (mg/kg)	239	J	360	J	487	J	578	J	376	J
Nickel (mg/kg)	9.1		12		16.2		11		11.2	
Potassium (mg/kg)	657	J	586	J	811	B	551	B	671	B
Silver (mg/kg)	1.1	U	1	U	0.93	U	0.93	U	0.85	U
Sodium (mg/kg)	137	J	137	J	148	J	192	J	150	J
Vanadium (mg/kg)	35.2		31.8		44.5		38.4		38.5	
Zinc (mg/kg)	77.4		98		99.7	J	168	J	142	J
		2σ		2σ		2σ		2σ		2σ
Gross Alpha	0	5	8	5	16	6	11	5	10	5
Gross Beta	317	8	51	3	30	3	19	2	18	2
Sr(90)	207	42	24.5	2.3	<0.6		<0.4		<0.6	
Tc(99)	N/A		N/A		N/A		N/A		N/A	
Gamma Scan										
K(40)	12	0.51	12.67	0.48	14.05	0.52	12.61	0.47	11.94	0.5
Cr(51)	<1.321		<1.156		<0.8328		<0.7524		<0.8781	
Mn(54)	N/A		N/A		N/A		N/A		N/A	
Co(60)	2.757	0.079	4.973	0.092	1.061	0.05	0.8205	0.0434	1.389	0.056
Zn(65)	<0.1054		<0.1374		<0.07695		<0.08487		<0.08317	
Sb(124)	1.238	0.086	0.6447	0.0739	N/A		0.07515	0.0529	0.0622	0.0571
Cs(134)	<0.0445		<0.05017		<0.03584		<0.03372		<0.03501	
Cs(137)	0.1036	0.0407	0.1473	0.0381	0.07691	0.0251	0.3096	0.0263	0.1563	0.0298
Ce (141)	N/A		N/A		N/A		N/A		N/A	
Eu(152)	N/A		0.1143	0.0716	N/A		0.2353	0.0374	0.102	0.0394
Eu(154)	N/A		N/A		N/A		N/A		N/A	
Eu(155)	N/A		N/A		N/A		N/A		N/A	
Ra(226)	0.7963	0.569	0.7497	0.0719	0.9031	0.0534	0.9103	0.0467	0.7013	0.0588
Th(228)	0.8437	0.0415	0.9384	0.0348	1.225	0.037	0.8443	0.0289	0.7534	0.0325
Th(232)	0.7391	0.1696	0.8856	0.2113	1.1	0.14	0.8787	0.1259	0.735	0.1321
U(235)	N/A		N/A		0.1084	0.0832	N/A		N/A	

Site Identification	100H		100H		100H		100H		100H	
Coordinates E (m)	577080		577255		577330		577885		578235	
Coordinates N (m)	153770		153660		153615		153160		152660	
River Mile (nearest 0.1 mi	14.4		14.5		14.6		15.0		15.4	
Date	9/20/91		9/20/91		9/25/91		9/26/91		10/21/91	
OSM Sample No.	B01581	Q	B01587	Q	B01591	Q	B01595	Q	B015D6	Q
Quality Control Sample										
Aluminum (mg/kg)	6360		5410		9150		6540		5700	
Antimony (mg/kg)	12.4	J	12	J	16	UJ	12.7	UJ	11.3	UJ
Barium (mg/kg)	60.7		45.4	B	76.5	J	53.5	J	69.1	
Beryllium (mg/kg)	0.25	U	0.26	U	0.63	B	0.3	B	0.24	U
Cadmium (mg/kg)	0.76	U	0.77	U	1	U	0.81	U	0.72	U
Calcium (mg/kg)	3660		5660		4810	J	3690	J	3460	
Chromium (mg/kg)	19.7		107		45.6	J	23.9	J	47.3	J
Cobalt (mg/kg)	8.4	B	7.3	B	8.4	B	6.3	B	8.1	B
Copper (mg/kg)	29.5	J	24.6	J	31.6		23.4		24.9	
Iron (mg/kg)	15100		17000		18200	J	13500	J	16400	J
Magnesium (mg/kg)	3900		3280		4890		3870		3680	
Manganese (mg/kg)	296		253		457	J	180	J	285	
Nickel (mg/kg)	9.2	B	11.4		17.4		11.7		11.2	
Potassium (mg/kg)	784	B	626	B	1160	B	837	B	569	B
Silver (mg/kg)	1	U	1	U	1.4	U	1.1	U	0.96	U
Sodium (mg/kg)	223	B	210	B	311	J	256	J	169	J
Vanadium (mg/kg)	28.5		26.1		40.8		28.7		37.5	
Zinc (mg/kg)	217		204		364	J	226	J	174	
		2σ		2σ		2σ		2σ		2σ
Gross Alpha	7	4	6	4	6	4	7	3	8	5
Gross Beta	18	3	22	2	13	2	23	2	19	2
Sr(90)	0.3	0.2	0.2	0.1	<0.3		<2		0.9	0.3
Tc(99)	0.2	0.1	0.2	0.1	0.4	0.1	<0.2		0.23	0.09
Gamma Scan										
K(40)	12.18	0.46	13.32	0.46	13.65	0.48	15.17	0.63	12.28	0.49
Cr(51)	<1.118		<1.107		<1.165		<1.429		<0.7025	
Mn(54)	N/A		N/A		N/A		N/A		N/A	
Co(60)	0.1773	0.0308	0.03679	0.0163	0.1841	0.0304	0.04706	0.033	0.06885	0.0204
Zn(65)	<0.06644		<0.05917		<0.08423		<0.08798		<0.06566	
Sb(124)	N/A		N/A		N/A		N/A		N/A	
Cs(134)	<0.02756		<0.0275		<0.04359		<0.03424		<0.03007	
Cs(137)	0.249	0.0282	0.1872	0.0167	0.5202	0.0355	0.1693	0.0329	0.1676	0.0296
Ce (141)	N/A		N/A		N/A		N/A		N/A	
Eu(152)	N/A		N/A		0.636	0.0491	N/A		0.2118	0.0435
Eu(154)	N/A		N/A		0.09269	0.0643	N/A		N/A	
Eu(155)	N/A		N/A		0.07585	0.0482	0.08437	0.0577	0.05851	0.0476
Ra(226)	0.6557	0.0423	0.7618	0.0473	0.7688	0.0514	0.7429	0.0627	0.7838	0.0055
Th(228)	0.8222	0.0302	1.156	0.032	1.092	0.032	0.9273	0.0353	1.159	0.035
Th(232)	0.7827	0.092	1.07	0.105	1.123	0.102	0.9533	0.1173	1.196	1.106
U(235)	N/A		N/A		0.08449	0.0723	N/A		N/A	

Site Identification	100F		100F		100F		100F		100F	
Coordinates E (m)	580820		581230		582864		582864		582962	
Coordinates N (m)	148275		147940		145130		145130		144813	
River Mile (nearest 0.1 mi	18.7		19.0		21.6		21.6		21.8	
Date	9/27/91		9/27/91		9/29/91		9/29/91		9/28/91	
OSM Sample No.	B01599	Q	B01597	Q	B015B5	Q	B015B7	Q	B015B3	Q
Quality Control Sample							Dup. B015B5			
Aluminum (mg/kg)	5460		6120		6920		6790		6630	
Antimony (mg/kg)	11.2	UJ	11.1	UJ	13.6	UJ	12.8	UJ	11.6	UJ
Barium (mg/kg)	49.9	J	67.9	J	65.5	J	66	J	53.4	J
Berylium (mg/kg)	0.26	B	0.43	B	0.53	B	0.3	B	0.25	U
Cadmium (mg/kg)	0.72	U	0.71	U	0.87	U	0.82	U	0.74	U
Calcium (mg/kg)	3300	J	2770	J	4030	J	5320	J	4230	J
Chromium (mg/kg)	10	J	20.7	J	20	J	17.4	J	17.1	J
Cobalt (mg/kg)	6.1	B	5.9	B	7.1	B	6.9	B	8.2	B
Copper (mg/kg)	20.1		16.4		21		20.9		19.8	
Iron (mg/kg)	13700	J	13100	J	16500	J	16100	J	18800	J
Magnesium (mg/kg)	3640		3760		4320		4080		4370	
Manganese (mg/kg)	283	J	236	J	217	J	201	J	276	J
Nickel (mg/kg)	10		11.8		12.6		12.2		14	
Potassium (mg/kg)	648	B	554	B	951	B	977	B	847	B
Silver (mg/kg)	0.96	U	0.94	U	1.2	U	1.1	U	0.99	U
Sodium (mg/kg)	186	J	137	J	229	J	247	J	232	J
Vanadium (mg/kg)	31		30.6		33.9		32.4		46.7	
Zinc (mg/kg)	109	J	58.9	J	252	J	244	J	160	J
		2σ		2σ		2σ		2σ		2σ
Gross Alpha	8	5	8	5	2	4	6	4	14	5
Gross Beta	20	3	20	2	23	3	23	3	24	3
Sr(90)	<1		20	10	<40		<0.1		<0.4	
Tc(99)	N/A		N/A		N/A		N/A		N/A	
Gamma Scan										
K(40)	13.85	0.46	12.61	0.52	14.63	0.58	15.6	0.62	13.4	0.53
Cr(51)	<0.9772		<1.267		<1.514		<1.376		<1.434	
Mn(54)	N/A		N/A		N/A		N/A		N/A	
Co(60)	0.09524	0.0241	0.1527	0.0358	0.0625	0.0327	0.07504	0.0427	0.07961	0.0239
Zn(65)	<0.06065		<0.09422		<0.08293		<0.09958		<0.07365	
Sb(124)	N/A		N/A		N/A		0.1146	0.1087	N/A	
Cs(134)	<0.02448		<0.03739		<0.03808		<0.0502		<0.03529	
Cs(137)	0.1499	0.024	0.1856	0.0291	0.4385	0.0377	0.487	0.0295	0.2593	0.0332
Ce (141)	N/A		N/A		N/A		N/A		N/A	
Eu(152)	N/A		0.7582	0.0552	0.3123	0.0555	0.275	0.0586	0.2889	0.0394
Eu(154)	N/A		0.1637	0.0778	N/A		N/A		N/A	
Eu(155)	0.3257	0.0346	0.06641	0.0532	0.07591	0.0701	N/A		N/A	
Ra(226)	0.5516	0.0467	0.7593	0.0569	0.8032	0.0492	0.8015	0.0703	0.8274	0.0543
Th(228)	0.7475	0.0268	1.238	0.036	1.181	0.042	1.127	0.039	1.559	0.043
Th(232)	0.67	0.0868	1.228	0.128	1.073	0.15	1.11	0.128	1.497	0.111
U(235)	N/A		N/A		N/A		N/A		N/A	

Site Identification	100F		HAN		HAN		HAN	
Coordinates E (m)	583132		584986		585059		585729	
Coordinates N (m)	144317		140838		140777		140070	
River Mile (nearest 0.1 mi	22.1		24.6		24.7		25.2	
Date	9/28/91		10/2/91		10/2/91		10/2/91	
OSM Sample No.	B015B1	Q	B015C4	Q	B015C6	Q	B015C2	Q
Quality Control Sample					Dup. B015C4			
Aluminum (mg/kg)	5240		9350		9220		6410	
Antimony (mg/kg)	4.3	J	6.9	UJ	6.7	UJ	5	J
Barium (mg/kg)	65.1		87	B	98.8		74.2	
Beryllium (mg/kg)	0.23	U	0.49	U	0.48	U	0.24	U
Cadmium (mg/kg)	0.99	U	2.7		1.9	B	0.79	U
Calcium (mg/kg)	10000		5060		5140		4200	
Chromium (mg/kg)	10.2		22.1		21.9		12.1	
Cobalt (mg/kg)	7.5	B	10.2	B	11.5	B	8.3	B
Copper (mg/kg)	15.1	J	29	J	26	J	14.3	J
Iron (mg/kg)	16200		24600		30400		19200	
Magnesium (mg/kg)	3690		4650		4620		3900	
Manganese (mg/kg)	308	J	313	J	338	J	373	J
Nickel (mg/kg)	10.3		19.7		19.3		12.2	
Potassium (mg/kg)	641	B	1300	B	1160	B	715	B
Silver (mg/kg)	1.1	U	2.5	U	2.4	U	1.2	U
Sodium (mg/kg)	225	J	293	J	275	J	148	J
Vanadium (mg/kg)	40.2		70		82.2		46.7	
Zinc (mg/kg)	148		333		291		163	
		2σ		2σ		2σ		2σ
Gross Alpha	6	4	12	5	8	5	12	5
Gross Beta	24	3	21	2	20	3	25	3
Sr(90)	<0.1		<2		<2		<0.1	
Tc(99)	N/A		N/A		N/A		N/A	
Gamma Scan								
K(40)	13.45	0.49	12.17	0.58	12.73	0.6	11.46	0.55
Cr(51)	<1.347		<1.444		<1.481		<1.273	
Mn(54)	N/A		0.02639	0.0209	N/A		N/A	
Co(60)	0.25	0.0339	0.07702	0.0327	0.0708	0.033	0.2195	0.0387
Zn(65)	<0.08905		<0.08637		<0.1		<0.09235	
Sb(124)	N/A		N/A		N/A		N/A	
Cs(134)	<0.03385		<0.06024		<0.0434		<0.04514	
Cs(137)	0.5897	0.0257	0.2567	0.0245	0.3438	0.0402	0.4769	0.029
Ce (141)	N/A		N/A		0.1507	0.1226	N/A	
Eu(152)	0.7372	0.0509	0.3765	0.06	0.3416	0.0697	0.755	0.0595
Eu(154)	0.08792	0.07	N/A		N/A		N/A	
Eu(155)	0.08477	0.0498	0.08673	0.0783	N/A		N/A	
Ra(226)	0.8573	0.0521	1.273	0.073	1.184	0.076	1.108	0.072
Th(228)	1.51	0.035	1.913	0.05	1.76	0.048	1.185	0.042
Th(232)	1.563	0.124	1.708	0.143	1.649	0.165	1.185	0.144
U(235)	N/A		N/A		0.1069	0.87	N/A	

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